Pavement Management

Pavement Rehabilitation Manual

VOLUME II: TREATMENT SELECTION

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PAVEMENT REHABILITATION MANUAL

VOLUME II: TREATMENT SELECTION

M.A.P. Code 7.42-4-4
December 1991

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Albany, New York 12232

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ACKNOWLEDGMENTS

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PART 1: INTRODUCTION

PART 1: INTRODUCTION

This book on selection of treatments is Volume II of the Materials Bureau's Pavement Rehabilitation Manual. It is to be used in conjunction with Volume I: Pavement Evaluation, published in June 1990. Volume II shows how pavement and/or shoulder distress data, collected in accord with procedures outlined in Volume I, are used to select rehabilitation alternatives, develop strategies and life-cycle costs for those alternatives, and choose proper rehabilitation alternatives. This volume completes the Pavement Rehabilitation Manual. New developments and additions will be handled through the Department's Engineering Instruction process.

Part 2 ("Treatment Guidelines and Typical Sections") is a compilation of current Department pavement rehabilitation treatments, ranging from preventive maintenance to total reconstruction. Included are guidelines maximizing each treatment's effectiveness based on pavement condition (distress levels), and typical section drawings listing work items necessary for success of each treatment. Service lives have been estimated for all treatments based on current experience and engineering judgment. Refinements of these estimates may be necessary as treatment performance histories are developed.

Short isolated areas within a proposed project may exhibit pavement distresses dissimilar to those found on the project in general. It is thus likely that more than one pavement rehabilitation treatment will be required on a project.

Part 3 on life-cycle-cost analysis presents a methodology for comparing treatment costs, the goal being to select a present and future treatment strategy for a pavement with the wisest use of funds. Also included in this chapter are information sources for specification items and costs.

Volume II also contains as Part 4 a model report on pavement evaluation and treatment selection, to give the user an example of format and methodology.

With these "tools" the user can select alternatives and plan a treatment strategy for each alternative. These strategies can then be compared for cost effectiveness and final selection. Once completed, performance of the selected strategy should be followed to verify service life assumptions, learn the influence of variables, and refine the analysis for future rehabilitation strategies.

Users of this Manual are cautioned that selection of a rehabilitation strategy should not be based on existing pavement condition alone. Other less obvious deficiencies, such as unfavorable soil conditions and inadequate drainage characteristics, may have a profound effect on strategy selection and project scope. Also, design and/or construction constraints and maintenance concerns and capabilities must be considered during the selection process.

It is thus recommended that technical assistance be solicited from those regional and/or Main Office units having expertise in these areas during the selection process.

The general procedure for treatment selection includes ten steps:

1. Review the condition report generated by following procedures in Volume I: Pavement Evaluation.

2. Solicit information from regional and/or Main Office units that could influence treatment selection.

3. Select appropriate initial treatment alternatives based on pavement condition and the treatment guidelines presented here.

4. Eliminate any initial alternatives that are inappropriate due to design, construction, or other constraints.

5. Develop a treatment strategy for each alternative using expected service life of the initial treatment and projected future treatments.

6. Determine costs of all initial and future treatments using prices from past projects or estimates for new items.

7. Compare total costs of the alternative strategies, using the methods presented here.

8. Perform a "Sensitivity Analysis" if desirable.

9. Select the best treatment strategy based on cost and other factors.

10. Document pavement performance to improve future strategy development.

PART 2: TREATMENT GUIDELINES AND TYPICAL SECTIONS

Rigid Pavement
Flexible Pavement
Flexible-Over-Rigid Pavement
Pavement Widening
Flexible Shoulder

PART 2: TREATMENT GUIDELINES AND TYPICAL SECTIONS

This part of Volume II is divided into three sections representing three pavement types: rigid, flexible, and flexible-over-rigid. Each section is further divided into four categories for various pavement treatments: Preventive Maintenance, Corrective Maintenance, Pavement Rehabilitation, and Pavement Reconstruction. Finally, treatments for pavement widening and treatment categories for shoulder maintenance and repair are discussed.

1. Preventive Maintenance. Treatments preventing future deterioration or correcting minor defects to retard further damage and allow roadway surfaces to achieve their desired service lives. These do not improve roadway strength, rideability, or appearance.

2. Corrective Maintenance. Treatments correcting existing deficiencies, upgrading the roadway surface for up to 8 years or until other more-extensive treatments are needed.

3. Pavement Rehabilitation. Treatments intended to extend service life of a roadway surface 8 years or more. To be effective, treatment selection is critical and should be based on amount and severity of existing pavement distress.

4. Pavement Reconstruction. Treatments to be considered when condition of the existing pavement is such that it can no longer serve a useful purpose, when design constraints preclude rehabilitation, or when a life-cycle-cost analysis reveals that reconstruction is the most appropriate solution.

Each pavement treatment guideline is presented in the following format;

1. Conditions For Use
2. Constructability
3. Performance
4. Expected Failure Modes
5. Expected Service Life

Except for reconstruction treatments, a typical section drawing is shown for each pavement treatment, listing appropriate repair items necessary for developing treatment costs. For reconstruction treatments, the Department's standard typical sections should be used to develop costs.

"Expected Service Life" in these guidelines is based on past research and current performance experience. It is appropriate for highways with Average Annual Daily Traffic counts (AADTs) of 12,000 to 35,000 with about 5-percent trucks. Service life should be

adjusted for highways with traffic outside these limits. Some guidelines are meant only for low-volume roadways, as noted under "Conditions For Use."

The ideal method to change or correct service life is by referring to a pavement work history file. A uniform statewide work history file is being developed as part of the Department's Pavement Management Initiative. Lacking this, similar treatments on highways carrying similar traffic volumes should be observed to estimate service life. Pavement performance for the various treatments should be followed and added to a work history file for future decision-making. Service life adjustments should be made using as many facts as possible, following a logical process and saving the information for future use.

Pavement deterioration results from the environment and traffic, but some treatments are not expected to change significantly with traffic. For instance, sealed or filled joints or cracks should not change, as their performance is based on temperature-induced movement and not traffic. However, traffic and environment affect other treatments and adjustments in their service lives are appropriate.

Part 4 ("Model Pavement Evaluation Report") in this volume shows a service life adjustment. In this example, estimated service life was decreased when overlay treatment thickness was reduced.

Thickness dimensions for asphalt overlays in the guidelines are considered nominal. Minor adjustments to these thicknesses are appropriate when local practice and performance dictate. However, caution is advised in reducing thicknesses. A thickness found in the guidelines should always be used as a minimum on interstate system roadways.

RIGID PAVEMENT
TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance
Joint and Crack Filling
Joint and Crack Sealing

Corrective Maintenance
Joint and Crack Sealing With Spall Repair
Joint and Crack Sealing With Spall Repair and Grinding
Joint and Crack Sealing With Spall Repair, Grinding,
and Full-Depth Segment Replacement

Rehabilitation
Joint and Crack Sealing With Spall Repair and Full-Depth Segment Replacement
Bonded Concrete Overlay
Sawed and Sealed Asphalt Concrete Overlay (3")
Sawed and Sealed Asphalt Concrete Overlay (4")
Asphalt Concrete Overlay (5") Preceded by Cracking and Seating
Asphalt Concrete Overlay (6") Preceded by Rubblizing

Reconstruction
Full-Depth Portland Cement or Asphalt Concrete

Joint and Crack Filling

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals or filler, or slab cracks never sealed or filled.
2. Medium-severity pavement/shoulder separation.
3. Other distresses at the none or low-severity level.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Restricted by temperature and moisture.
   b. Cracks must be clean for the filler to be effective.

Performance

1. Reduces incompressibles and water infiltration.
2. Helps to achieve desired pavement service life.

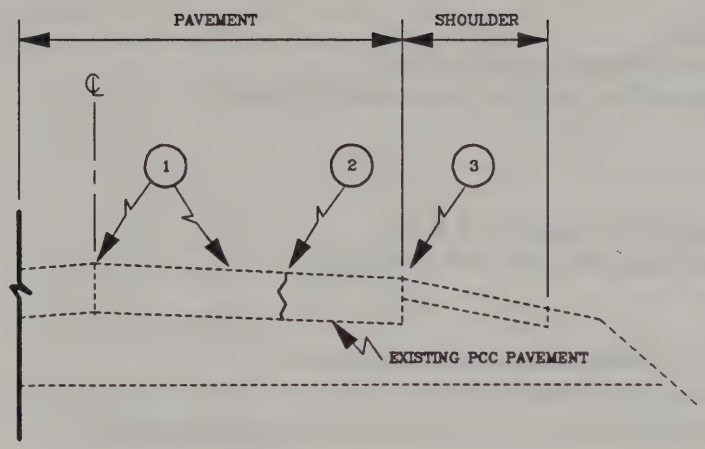
Expected Failure Modes

1. Fillers fail in adhesion or cohesion.
2. Wear by traffic.

Expected Service Life

2 years

2. Typical Section



1. Clean and fill longitudinal and transverse joints.
2. Clean and fill slab cracks.
3. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent medium-severity slab cracks.
3. Other distresses at the none or low-severity level.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.

Performance

1. Retards development of spalls and faults from incompressibles and water infiltration.
2. Needed to achieve desired pavement service life.

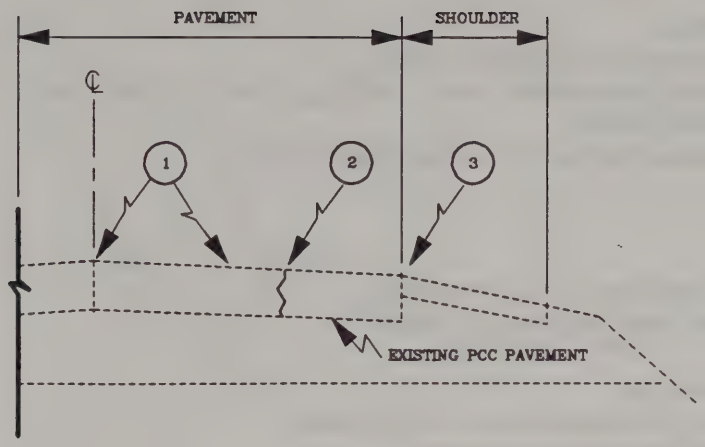
Expected Failure Modes

1. Seals fail in adhesion or cohesion.

Expected Service Life

8 years

2. Typical Section



1. Clean and seal longitudinal and transverse joints.
2. Rout, clean, and seal slab cracks.
3. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing With Spall Repair

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent medium-severity slab cracks.
3. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or scaling/non-joint spalling.
4. Other distresses at the none or low-severity level.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Sealing disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.

3. Spall repair disadvantages
   a. Restricted by temperature and moisture.
   b. Sounding required to detect delaminations for spall repair.
   c. Requires intensive preparation of the spalled area.

Performance

1. Sealing
   a. Retards development of spalls and faults from incompressibles and water infiltration.
   b. Needed to achieve desired pavement service life.

2. Spall repair
   a. Restores ride by replacing lost material.
   b. Needed to achieve desired pavement service life.

Expected Failure Modes

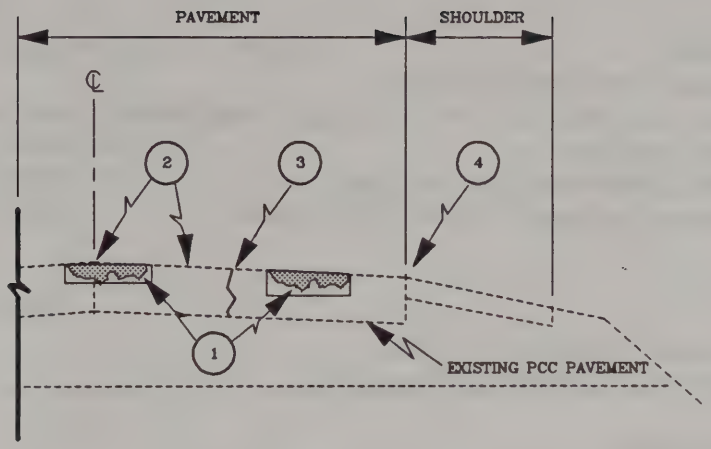
1. Sealing
   a. Seals fail in adhesion or cohesion.

2. Spall repair
   a. Loss of material due to cracking, delamination, or surrounding pavement failure.

Expected Service Life

1. Joint/crack sealing: 8 years
2. Spall repair: 10 years

2. Typical Section



1. Mill and patch spalls with rapid-setting concrete patching materials.
2. Clean and seal longitudinal and transverse joints.
3. Rout, clean, and seal slab cracks.
4. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing With Spall Repair and Grinding

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent medium-severity slab cracks.
3. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or scaling/non-joint spalling.
4. Medium-severity transverse joint faulting.
5. Other distresses at the none or low-severity level.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Sealing disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.

3. Spall repair disadvantages
   a. Restricted by temperature and moisture.
   b. Sounding required to detect delaminations for spall repair.
   c. Requires intensive preparation of the spalled area.

4. Grinding disadvantages
   a. Side clearance of the machine limits grinding near existing features (i.e., curbs and barriers).
   b. New joint seal reservoirs must be created.
   c. High reinforcing mesh damages grinding equipment.

Performance

1. Sealing
   a. Retards development of spalls and faults from incompressibles and water infiltration.
   b. Needed to achieve desired pavement service life.

2. Spall repair
   a. Restores ride by replacing lost material.
   b. Needed to achieve desired pavement service life.

3. Grinding
   a. Restores ride by removing faults (also improves pavement friction).

Expected Failure Modes

1. Sealing
   a. Seals fail in adhesion or cohesion.

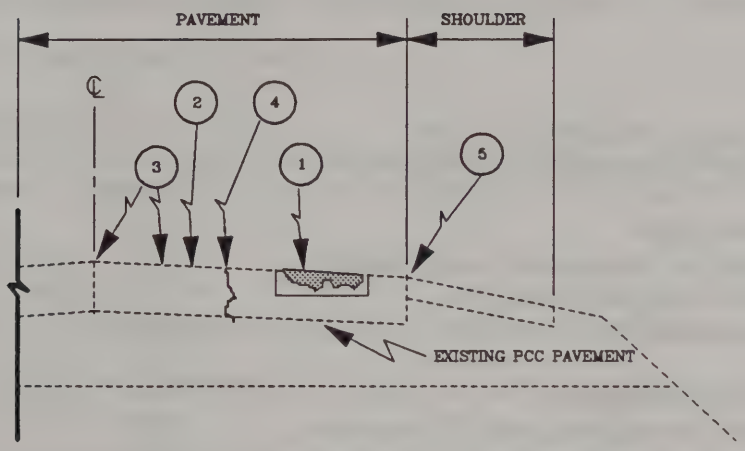
2. Spall repair
   a. Loss of material due to cracking, delamination, or surrounding pavement failure.

3. Grinding
   a. Traffic causes faults to return.

Expected Service Life

1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
3. Grinding: 5 years

2. Typical Section



1. Mill and patch spalls with rapid-setting concrete patching materials.
2. Grind faults.
3. Clean and seal longitudinal and transverse joints.
4. Rout, clean, and seal slab cracks.
5. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing With Spall Repair, Grinding, and Full-Depth Segment Replacement

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or medium- and/or high-severity scaling/non-joint spalling.
5. Medium-severity transverse joint faulting.
6. Infrequent settlements, heaves, and/or blowups.
7. Other distresses at the none or low-severity level.
   (Note: Distresses 2,3,4, and 6 are repaired with full-depth rapid-set cement concrete)

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Sealing disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.

3. Spall repair disadvantages
   a. Restricted by temperature and moisture.
   b. Sounding required to detect delaminations for spall repair.
   c. Requires intensive preparation of the spalled area.

4. Grinding disadvantages
   a. Side clearance of the machine limits grinding near existing features (i.e., curbs and barriers).
   b. New joint seal reservoirs must be created.
   c. High reinforcing mesh damages grinding equipment.

5. Full-depth segment replacement disadvantages
   a. Requires special preparation, equipment, and materials.

Performance

1. Sealing
   a. Retards spall and fault development from incompressibles and water infiltration.
   b. Needed to achieve desired pavement service life.

2. Spall repair
   a. Restores ride by replacing lost material.
   b. Needed to achieve desired pavement service life.

3. Grinding
   a. Restores ride by removing faults (also improves pavement friction).

4. Full-depth segment replacement
   a. Restores structural integrity by replacing cracked and displaced pavement.
   b. Restores ride by replacing lost or displaced pavement.

Expected Failure Modes

1. Sealing
   a. Seals fail in adhesion or cohesion.

2. Spall repair
   a. Loss of material due to cracking, delamination, or surrounding pavement failure.

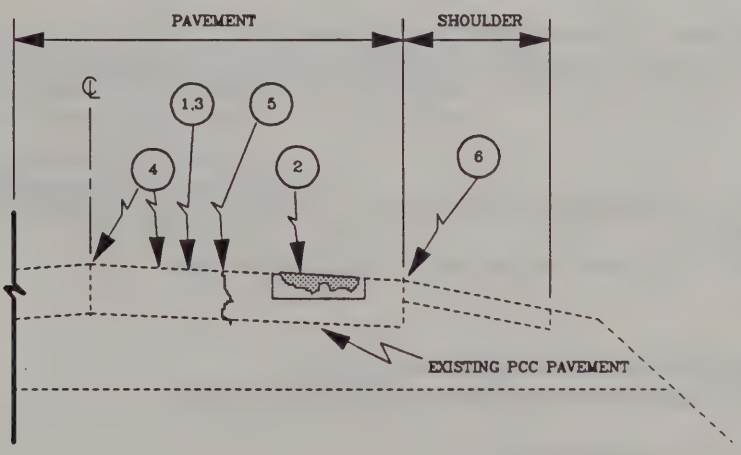
3. Grinding
   a. Traffic causes faults to return.

4. Full-depth segment replacement
   a. Fails in the same manner as any portland cement concrete pavement.
   b. Adjacent pavement failure may propagate into new segment.

Expected Service Life

1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
3. Grinding: 5 years
4. Full-depth segment replacement: equals or exceeds service life of the existing pavement up to 30 years.

2. Typical Section



1. Full-depth segment replacement with cement concrete.
2. Mill and patch spalls with rapid-setting concrete patching materials.
3. Grind faults.
4. Clean and seal longitudinal and transverse joints.
5. Rout, clean, and seal slab cracks.
6. Clean and fill pavement/shoulder joint.

(See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing With Spall Repair and Full-Depth Segment Replacement

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or medium- and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. Other distresses at the none or low-severity level.
   (Note: Distresses 2, 3, 4, and 5 are repaired with full-depth rapid-setting cement concrete)

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Sealing disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.

3. Spall repair disadvantages
   a. Restricted by temperature and moisture.
   b. Sounding required to detect delaminations for spall repair.
   c. Requires intensive preparation of the spalled area.

4. Full-depth segment replacement disadvantages
   a. Requires special preparation, equipment, and materials.

Performance

1. Sealing
   a. Retards development of spalls and faults from incompressibles and water infiltration.
   b. Needed to achieve desired pavement service life.

2. Spall repair
   a. Restores ride by replacing lost material.
   b. Needed to achieve desired pavement service life.

3. Full-depth segment replacement
   a. Restores structural integrity by replacing cracked and displaced pavement.
   b. Restores ride by replacing lost or displaced pavement.

Expected Failure Modes

1. Sealing
   a. Seals fail in adhesion or cohesion.

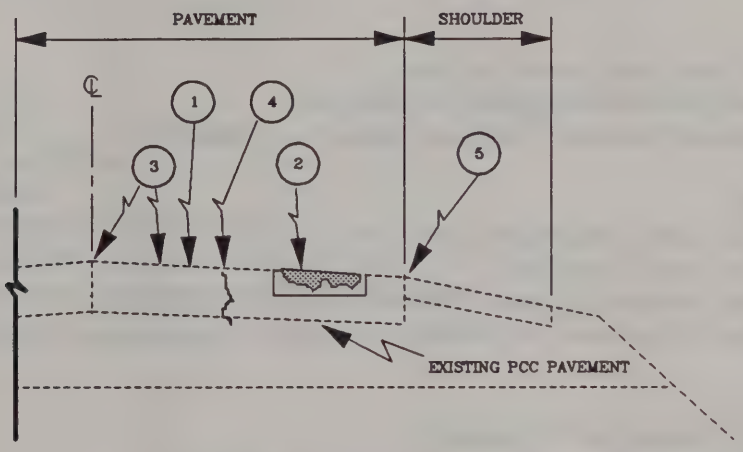
2. Spall repair
   a. Loss of material due to cracking, delamination, or surrounding pavement failure.

3. Full-depth segment replacement
   a. Fails in the same manner as any portland cement concrete pavement.
   b. Adjacent pavement failure may propagate into new segment.

Expected Service Life

1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
3. Full-depth segment replacement: equals or exceeds service life of the existing pavement up to 30 years.

2. Typical Section



1. Full-depth segment replacement with cement concrete.
2. Mill and patch spalls with rapid-setting concrete patching materials.
3. Clean and seal longitudinal and transverse joints.
4. Rout, clean, and seal slab cracks.
5. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)

Bonded Concrete Overlay

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent medium- and high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. Medium- and/or high-severity transverse and/or longitudinal joint spalling and/or medium- and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. Medium- and/or high-severity wheelpath rutting.
7. Other distresses at the none or low-severity level.
   (Note: Distresses 2, 3, and 5 are repaired with full-depth rapid-setting cement concrete)

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Uses normal concrete paving techniques.
   c. Rapid-strength-gaining concrete mixes are available.

2. Disadvantages
   a. Overnight lane closures are required.
   b. Achieving bond is critical.
   c. Sandblast cleaning is required, dust control is difficult.
   d. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, and cross-slope.
2. Increased thickness adds structural capacity, if required.
3. Less susceptible to rutting than asphalt concrete overlay.

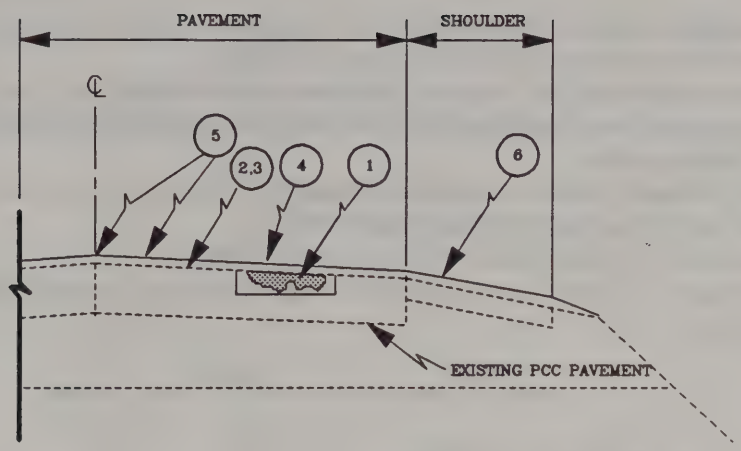
Expected Failure Modes

1. Sealer failure leading to spalls and blowups.
2. Underlying unrepaired cracks may reflect.

Expected Service Life

20 years with joint/crack resealing at 8-year intervals.

2. Typical Section



1. Mill out spalls.
2. Scarify 1/4", sandblast.
3. Clean pavement.
4. 3" cement concrete bonded overlay.
5. Saw and seal concrete over existing joints.
6. Asphalt concrete or cement concrete shoulder.

Sawed and Sealed Asphalt Concrete Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent medium- and/or high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. Medium-severity transverse and/or longitudinal joint spalling and/or medium-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. Medium- and/or high-severity wheelpath rutting.
7. Other distresses are at the none or low-severity level.
   (Note: Distresses 2, 3, and 5 are repaired with full-depth rapid-setting cement or asphalt concrete)

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Sawcuts must be properly located over underlying transverse joints.
   b. Sealers must be installed properly.
   c. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Asphalt concrete overlay
   a. Restores ride, friction, and cross-slope.

2. Saw and seal
   a. Controls reflection cracking.
   b. Seals keep water out of the pavement structure, preventing further joint distress.
   c. Seal must be maintained to achieve desired overlay service life.

3. Full-depth repairs
   a. Restore structural integrity.
   b. Needed to achieve desired overlay service life.

Expected Failure Modes

1. Asphalt concrete overlay
   a. Oxidation, ravelling, and/or rutting.
   b. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.

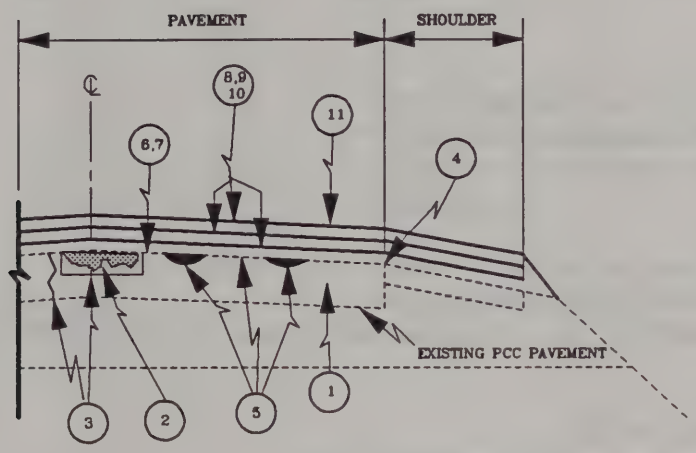
2. Saw and seal
   a. Failure to maintain the seal may lead to multiple cracks and potholes at transverse joints.

3. Full-depth repairs
   a. Asphalt concrete repairs are more likely to rut, shove, and/or heave causing bumps.

Expected Service Life

1. Asphalt concrete overlay: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Sawed and sealed joints: 8 years
3. Full-depth asphalt concrete repairs: life of the overlay with bump milling at 5-year intervals
4. Full-depth cement concrete repairs: 30 years

2. Typical Section



1. Full-depth segment replacement with cement or asphalt concrete.
2. Mill and patch spalls with rapid-setting cement or asphalt concrete.
3. Clean and fill joints and cracks.
4. Clean and fill pavement/shoulder joint.
5. Shim faults and wheel ruts.
6. Clean pavement.
7. Tack coat.
8. Asphalt concrete truing-and-leveling.
9. Asphalt concrete binder (1-1/2").
10. Asphalt concrete top (1-1/2").
11. Saw and seal new surface over existing transverse joints.

Sawed and Sealed Asphalt Concrete Overlay (4")

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent medium- and/or high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. Medium-severity transverse joint faulting.
7. High-severity wheelpath rutting.
   (Note: Distresses 2, 3, and 5 are repaired with full-depth rapid-setting cement or asphalt concrete)

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closure not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Sawcuts must be properly located over transverse joints.
   b. Sealers must be installed properly.
   c. 4" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Asphalt concrete overlay
   a. Restores ride, friction, and cross-slope.
   b. Increased thickness bridges patched spalls.
   c. Multiple-course placement results in smoother ride.

2. Saw and seal
   a. Controls reflection cracking.
   b. Seals keep water out of the pavement structure, preventing further joint distress.
   c. Seal must be maintained to achieve desired overlay service life.

3. Full-depth repairs
   a. Restore structural integrity.
   b. Needed to achieve desired overlay service life.

Expected Failure Modes

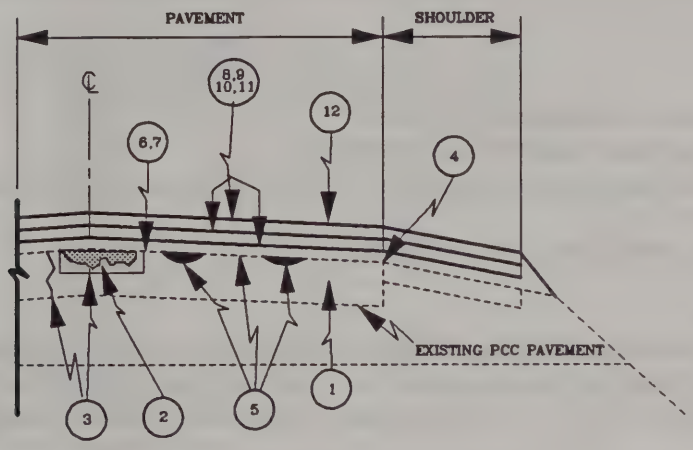
1. Asphalt concrete overlay
   a. Oxidation, ravelling, and/or rutting.
   b. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.
2. Saw and seal
   a. Failure to maintain the seal may lead to multiple cracks and potholes at transverse joints.

3. Full-depth repairs
    a. Asphalt concrete repairs are more likely to rut, shove, and/or heave causing bumps.

Expected Service Life

1. Asphalt concrete overlay: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Sawed and sealed joints: 8 years
3. Full-depth asphalt concrete repairs: life of the overlay with bump milling at 5-year intervals
4. Full-depth cement concrete repairs: 30 years

2. Typical Section



1. Full-depth segment replacement with cement or asphalt concrete.
2. Mill and patch spalls with rapid-setting cement or asphalt concrete.
3. Clean and fill joints and cracks.
4. Clean and fill pavement/shoulder joint.
5. Shim faults and wheel ruts.
6. Clean pavement.
7. Tack coat.
8. Asphalt concrete truing-and-leveling.
9. Initial asphalt course, asphalt concrete top (1").
10. Asphalt concrete binder (1-1/2").
11. Asphalt concrete top (1-1/2").
12. Saw and seal new surface over existing transverse joints.

Asphalt Concrete Overlay (5") Preceded by Cracking and Seating

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Medium- and/or high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. High-severity transverse joint faulting.
7. High-severity wheelpath rutting.
   (Note: Distresses 3 and 5 are repaired with full-depth asphalt concrete)

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Traffic can be maintained on the cracked and seated portland cement concrete pavement.
   d. Common rehabilitation technique.

2. Disadvantages
   a. Cracking and seating may create additional unexpected spalls.
   b. Has potential to disrupt culverts and underground utilities.
   c. 5" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Asphalt concrete overlay
   a. Restores ride, friction, and cross-slope.
   b. Increased thickness adds structural capacity and bridges patched spalls.

2. Crack and seat
   a. Minimizes reflection cracking.
   b. Reduction of reflection cracks keeps water from pavement structure.
   c. Crack filling may be necessary to achieve desired overlay service life.

3. Full-depth repairs
   a. Restore structural integrity.
   b. Needed to achieve desired overlay service life.

Expected Failure Modes

1. Asphalt concrete overlay
   a. Oxidation, ravelling, and/rutting.
   b. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.
   c. Failure to maintain reflection cracks may lead to multiple cracks and potholes.

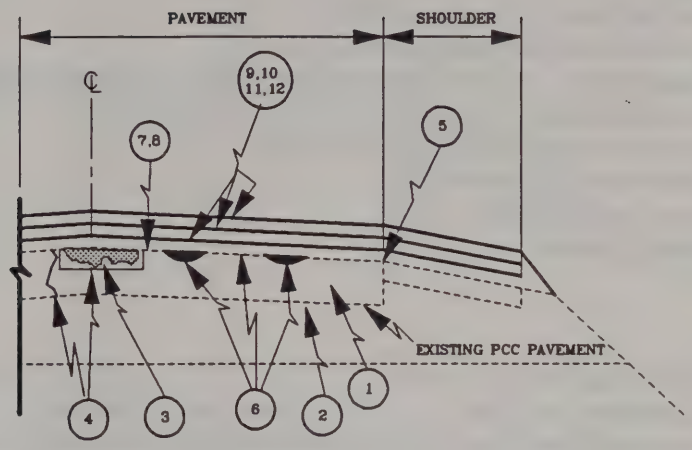
2. Full-depth repairs
   a. Asphalt concrete repairs are more likely to rut, shove, and/or heave causing bumps.
   b. Undowelled cement concrete repairs may heave causing bumps.

Expected Service Life

1. Asphalt concrete overlay: 15 years with full-width transverse crack sealing at 5-year intervals.

2. Full-depth repairs: life of the overlay with bump milling as necessary.

2. Typical Section



1. Full-depth segment replacement with cement or asphalt concrete.
2. Crack and seat existing pavement.
3. Mill and patch spalls with asphalt concrete.
4. Clean and fill joints and cracks.
5. Clean and fill pavement/shoulder joint.
6. Shim faults and wheel ruts.
7. Clean pavement.
8. Tack coat.
9. Asphalt concrete truing-and-leveling.
10. Initial asphalt concrete course, asphalt concrete binder (2").
11. Asphalt concrete binder (1-1/2").
12. Asphalt concrete top (1-1/2").

Asphalt Concrete Overlay (6") Preceded by Rubblizing

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Medium- and/or high-severity slab cracks.
3. Separated transverse and/or longitudinal joints.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. High-severity transverse joint faulting.
7. High-severity wheelpath rutting.
8. Widening is contemplated.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Does not damage utilities.
   c. Compaction and overlay use standard techniques.
   d. Spall repair and full-depth replacement are not necessary.
   e. Pavement widening, shoulder replacement, and filling depressions can be accomplished with crushed stone.

2. Disadvantages
   a. Traffic cannot be maintained on a rubblized surface until the initial asphalt concrete course is placed.
   b. Positive drainage is required.
   c. 6" thickness may be a problem for vertical clearance and appurtenances.
   d. Most roadway features will require adjustment.
   e. Rubblizing equipment cannot get closer than 3 ft to curbs.

Performance

1. Restores ride, friction, and cross-slope.
2. Eliminates reflection cracks.
3. Absence of reflection cracks keep water from the pavement structure.
4. Rubblized pavement provides a drainage layer.

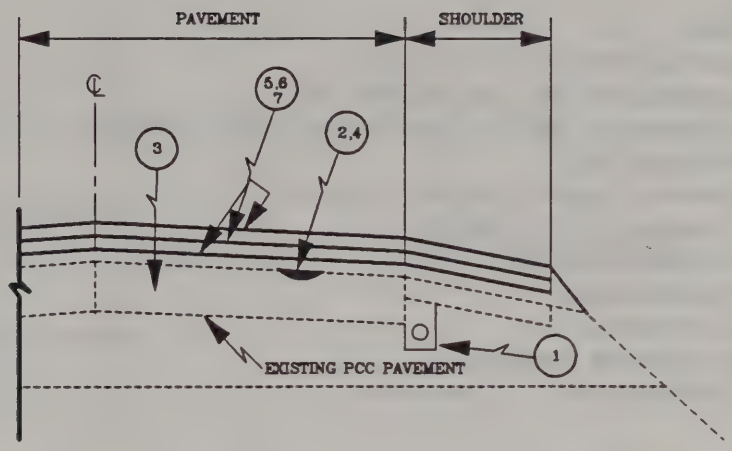
Expected Failure Modes

1. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Install edge drain.*
2. Remove asphalt patches and/or overlays.
3. Rubblize and compact existing pavement.**
4. Patch depressions with crushed stone.
5. Asphalt concrete base (3").
6. Asphalt concrete binder (1-1/2").
7. Asphalt concrete top (1-1/2").

* An alternative to edge drain installation is a daylighted crushed stone shoulder replacing the existing shoulder.

** Pavement may also be widened with crushed stone matching the thickness of the rubblized pavement.

Full-Depth Portland Cement or Asphalt Concrete

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Medium- and/or high-severity slab cracks.
3. Separated transverse and/or longitudinal joints.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Frequent settlements, heaves, and/or blowups.
6. High-severity transverse joint faulting.
7. High-severity wheelpath rutting.
8. Widening is contemplated.
9. Realignment is contemplated.
10. Existing profile must be maintained.
11. Extensive utility replacement is necessary.

Constructability

1. Advantages
   a. Uses standard techniques.
   b. Rapid-strength-gaining cement concrete mixes are available.
   c. Traffic can be maintained on the initial courses of asphalt concrete.

2. Disadvantages
   a. Overnight and/or long-term lane closures are required for cement concrete pavement.
   b. Must remove and dispose of existing pavement.

Performance

1. Ride, friction, and structural capacity of a new pavement is realized.
2. Joints and/or cracks must be maintained to achieve the desired pavement service life.

Expected Failure Modes

1. Asphalt concrete pavement
   a. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

2. Portland cement concrete pavement
   a. Joint seal failure, joint spalling, blowups, and/or fatigue cracking.

Expected Service Life

1. Asphalt concrete pavement: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Portland cement concrete pavement: 30 years with joint resealing at 8-year intervals.

FLEXIBLE PAVEMENT
TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance
- Crack Sealing
- Crack Filling

Corrective Maintenance
- Single-Course Overlay (1" to 1-1/2")
- Hot In-Place Recycle (1")
- Cold Milling and Replacement (1-1/2")

Rehabilitation
- Two-Course Overlay (3")
- Cold Milling With Single-Course Overlay (≥ 3")
- Hot In-Place Recycle With Single-Course Overlay (3")
- Cold In-Place Recycle With Single-Course Overlay (4-1/2")
- Multiple-Course Overlay (≥ 4")
- Cold Milling With Multiple-Course Overlay (≥ 4")
- Cold In-Place Recycle With Multiple-Course Overlay (6")

Reconstruction
- Asphalt Concrete Pavement Construction Above Existing Grade
- Full-Depth Portland Cement or Asphalt Concrete

Crack Sealing

1. Treatment Guidelines

Conditions For Use

1. Failed seals or full-width transverse cracks were never sealed.
2. Cracks are at the low-severity level.
3. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
4. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Requires intensive inspection.

Performance

1. Seals out water and incompressibles.
2. Retards development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

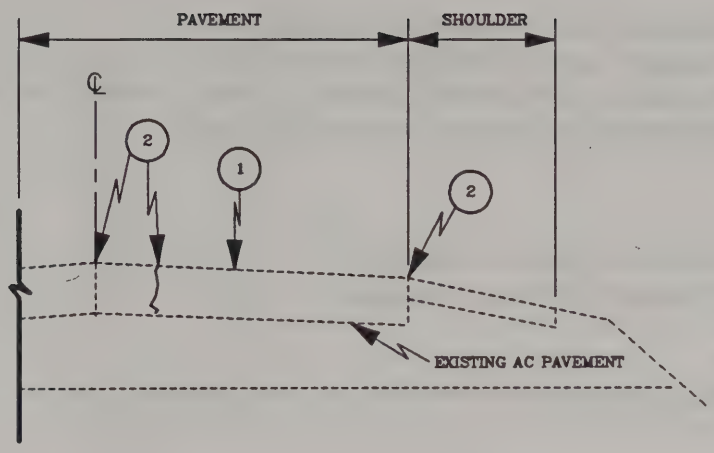
Expected Failure Modes

1. Sealer fails in adhesion or cohesion.

Expected Service Life

5 years.

2. Typical Section



1. Rout, clean, and seal transverse cracks.
2. Clean and fill cracks and pavement/shoulder joint.

Crack Filling

1. Treatment Guidelines

Conditions For Use

1. Failed seals or filler or cracks were never filled.
2. Cracks are in the low- and/or medium-severity level.
3. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
4. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Cracks must be clean for the filler to be effective.

Performance

1. Reduces incompressible and water infiltration.
2. Retards the development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

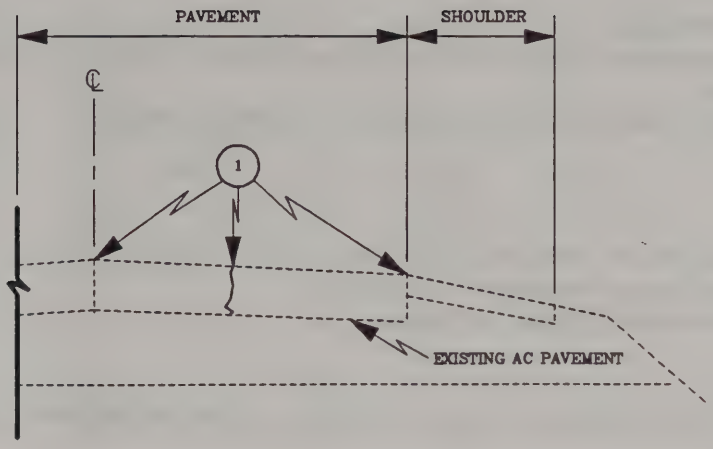
Expected Failure Modes

1. Filler fails in adhesion or cohesion.
2. Wear by traffic.

Expected Service Life

2 years.

2. Typical Section



1. Clean and fill cracks and pavement/shoulder joint.

Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, ravelling, and/or high-severity cracking.
3. Medium-severity wheelpath rutting and/or widening dropoff.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Crack filling, shimming wheel ruts are required to achieve service life.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

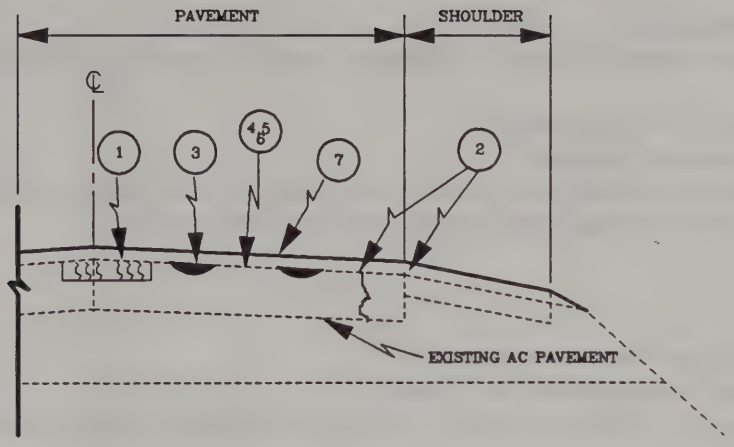
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat
6. Truing-and-leveling
7. Asphalt concrete top course (1" to 1-1/2").

Hot In-Place Recycle (1")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent settlements, heaves, slippage cracks, ravelling, and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations may be present.
5. Low or medium-severity wheelpath rutting and/or widening dropoff.
6. Pavement core evaluation must meet warrants for recycling.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.
   d. Maintains existing profile.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Smoke emissions may prohibit use in residential areas.
   c. Requires some virgin asphalt concrete.

Performance

1. Restores ride, friction, and cross-slope.
2. Improves the longitudinal construction joint.
3. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

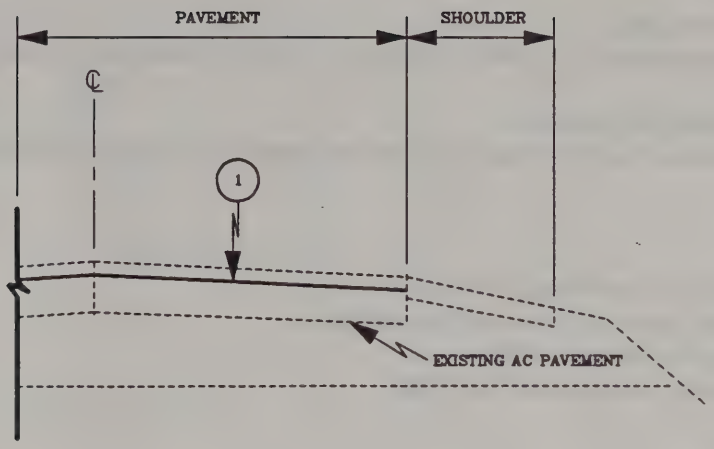
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Hot in-place surface recycling (1").

Cold Milling and Replacement (1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent settlements, heaves, slippage cracks, ravelling, and/or high-severity cracking.
3. Corrugations may be present.
4. Low- or medium-severity wheelpath rutting and/or widening dropoff.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Maintains existing profile.
   d. Requires no truing-and-leveling.

2. Disadvantages
   a. Millings must be disposed or recycled.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

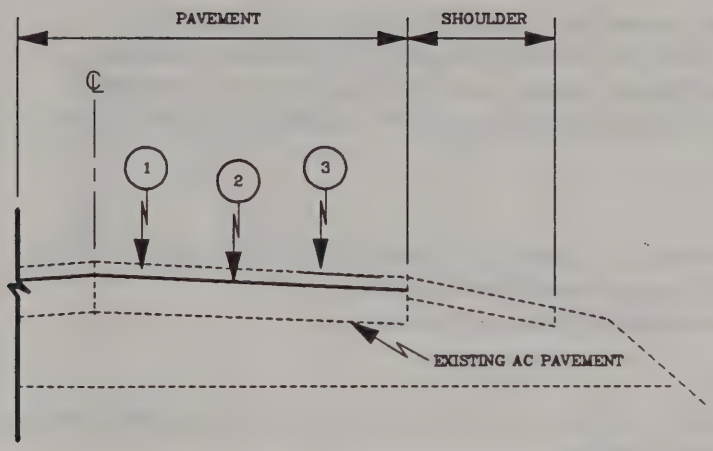
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold mill existing pavement surface (1-1/2").
2. Tack coat.
3. Asphalt concrete top course (1-1/2").

Two-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity wheelpath cracking and other cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closure not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Crack filling, shimming wheel ruts, and truing-and-leveling are required to achieve service life.
   b. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

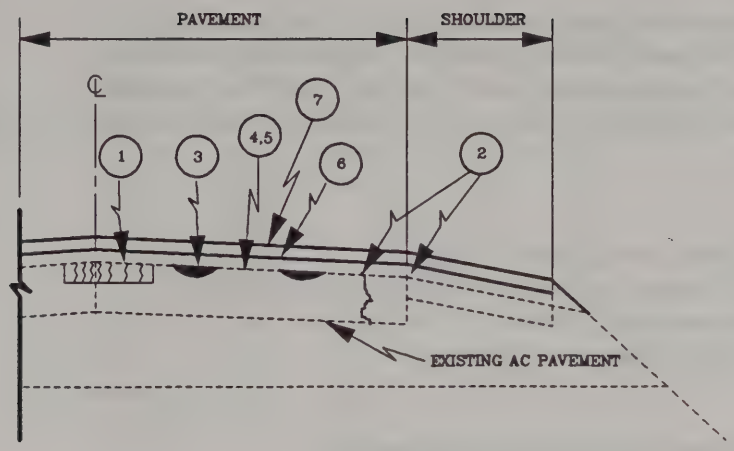
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling course.
6. Asphalt concrete binder course (1-1/2").
7. Asphalt concrete top course (1-1/2").

Cold Milling With Single-Course Overlay (≥ 3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity wheelpath cracking and other cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Maintains existing profile.
   d. Requires no truing-and-leveling.

2. Disadvantages
   a. Millings must be disposed or recycled.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks.

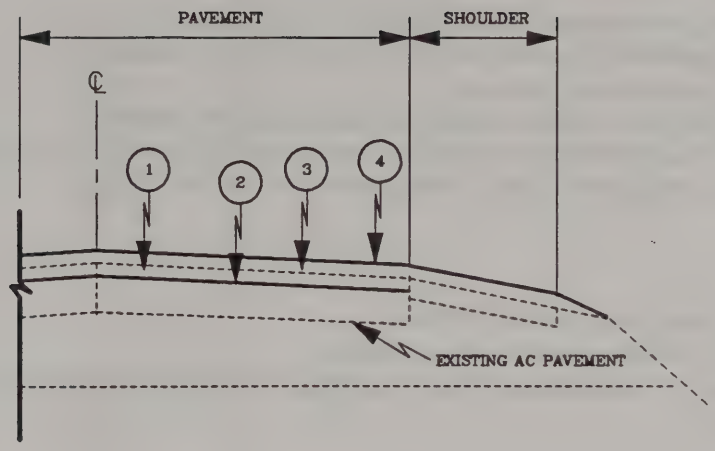
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold mill existing pavement surface (≥ 1-1/2").
2. Tack coat.
3. Asphalt concrete inlay course (≥ 1-1/2").
4. Asphalt concrete top course (1-1/2").

Hot In-Place Recycle With Single-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity wheelpath cracking and other cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations, slippage cracks, and ravelling may be present.
5. High-severity wheelpath rutting and/or widening dropoff may be present.
6. Pavement core evaluation must meet warrants for recycling.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Smoke emissions may prohibit use in residential areas.
   c. Requires some virgin asphalt concrete.

Performance

1. Restores ride, friction, and cross-slope.
2. Improves the longitudinal construction joint in the recycled layer.
3. Adds structural capacity.
4. Maintenance required early in overlay life to fill or seal reflective cracks.

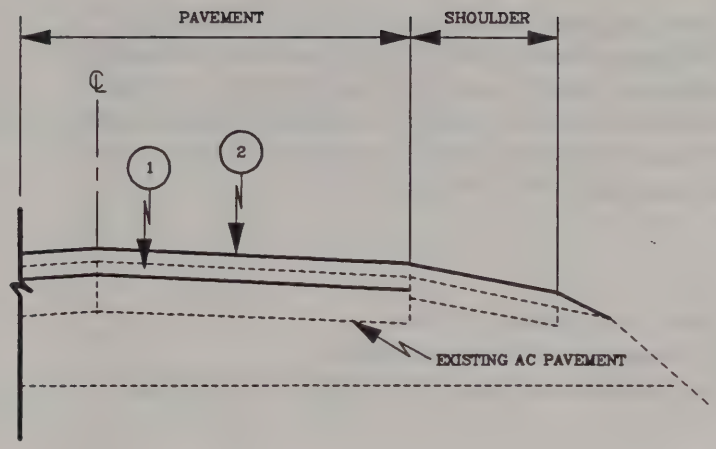
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Hot in-place recycle (1-1/2").
2. Asphalt concrete top course (1-1/2").

Cold In-Place Recycle With Single-Course Overlay (4-1/2")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity wheelpath cracking and other cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.
5. Pavement core evaluation must meet warrants for recycling.
6. Pavement must have low traffic volume .

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no crack sealing or shimming wheel ruts.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Truing-and-leveling may be required.

Performance

1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

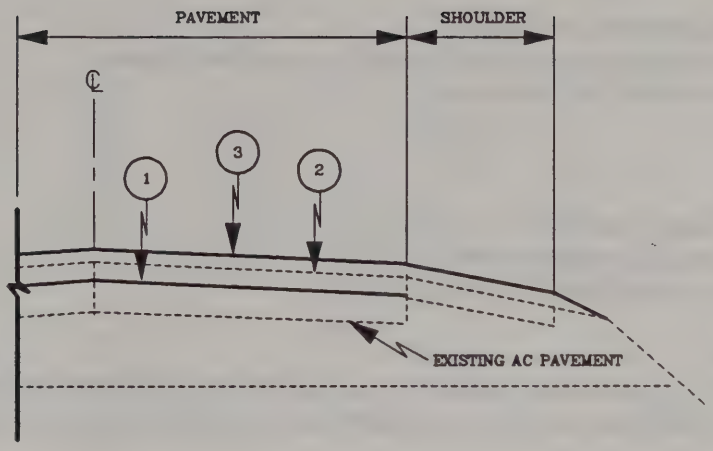
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete top course (1-1/2").

Multiple-Course Overlay (≥ 4")

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Crack filling, shimming wheel ruts, and truing-and-leveling are required.
   b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

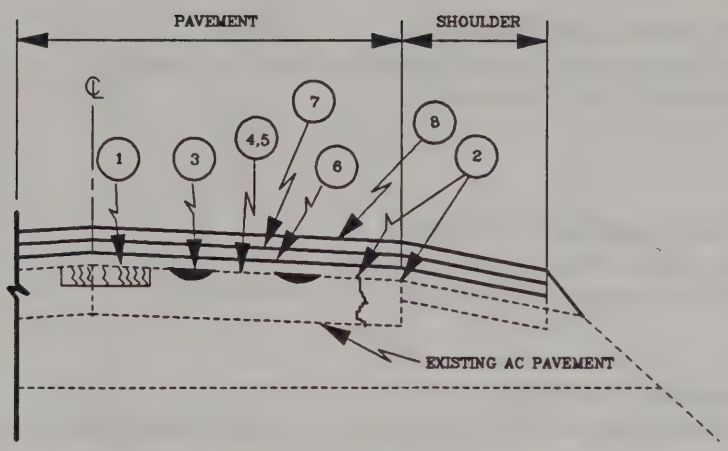
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling.
6. Asphalt concrete strengthening course (1" to 4").
7. Asphalt concrete binder course (1-1/2").
8. Asphalt concrete top course (1-1/2").

Cold Milling With Multiple-Course Overlay (≥ 4")

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no truing-and-leveling.

2. Disadvantages
   a. Must dispose of millings.
   b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

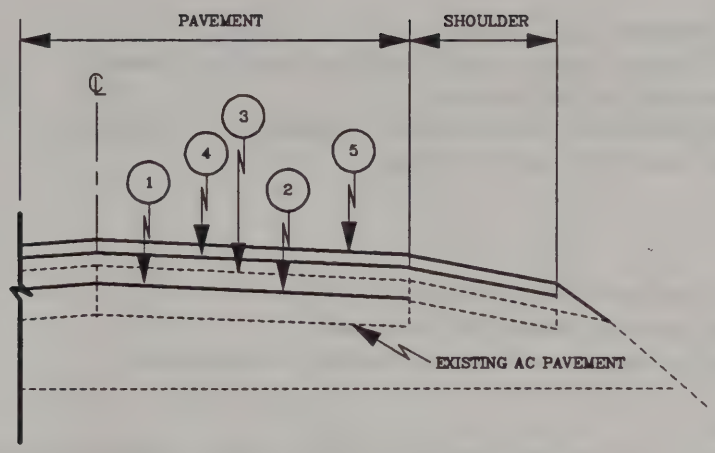
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold mill existing pavement surface (≥ 1").
2. Tack coat.
3. Asphalt concrete inlay and/or strengthening course (≥ 1"), multiple courses required for lifts >4".
4. Asphalt concrete binder course (1-1/2").
5. Asphalt concrete top course (1-1/2").

Cold In-Place Recycle With Multiple-Course Overlay (6")

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.
4. Pavement core evaluation should meet warrants for recycling.
5. Pavement must have low traffic volume.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no crack sealing or shimming wheel ruts.

2. Disadvantages
   a. Manholes or drainage inlets will damage the recycling equipment.
   b. Truing-and-leveling may be required.
   c. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

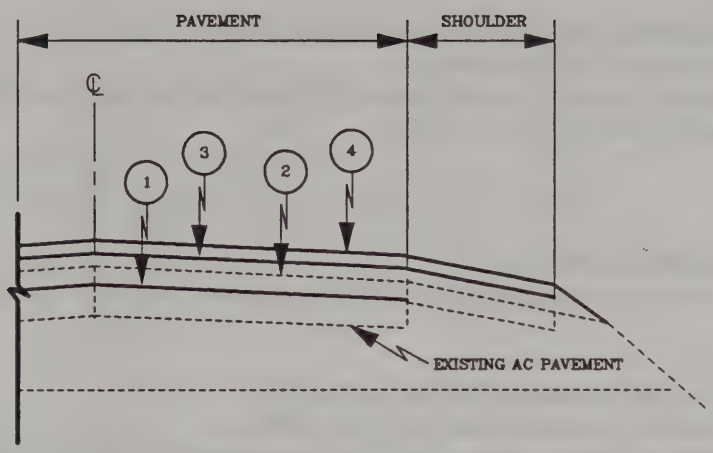
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete binder course (1-1/2").
4. Asphalt concrete top course (1-1/2").

Asphalt Concrete Pavement Construction Above Existing Grade

1. Treatment Guidelines

Conditions For Use

1. Corrugations, slippage cracks, and ravelling may be present.
2. Other distresses may be high-severity.
3. Existing pavement has low grade line with frost heaves and/or drainage problems over a substantial portion of its length.

Constructability

1. Advantages
   a. Uses standard techniques.
   b. Traffic can be maintained on initial courses of asphalt concrete.

2. Disadvantages
   a. Overnight lane closures may be required.
   b. Traffic has to be maintained on gravel fill.
   c. Higher grade line may be difficult to transition into existing facilities.

Performance

1. Ride, friction, and structural capacity of a new pavement are realized.
2. Better drainage and mitigation of frost problems are achieved.
3. Cracks must be maintained to achieve the desired pavement service life.

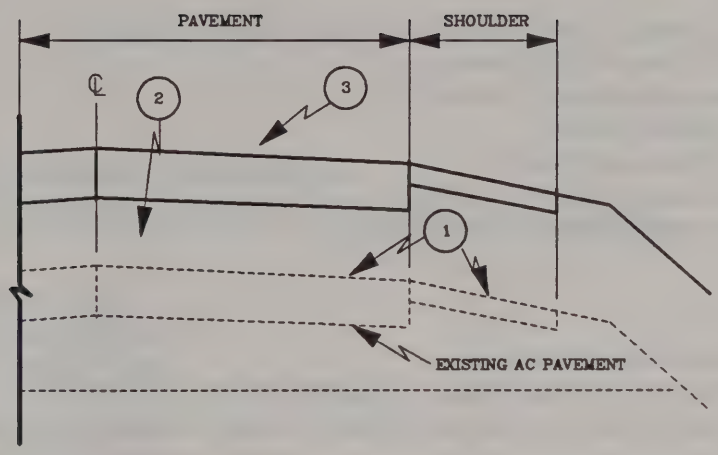
Expected Failure Modes

1. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Scarify existing pavement and shoulder.
2. Construct and compact new fill and subbase.
3. Construct new pavement and shoulder.

Note: If distance between bottom of the new pavement and surface of the old is less than 12", then the old pavement should be removed.

Full-Depth Portland Cement or Asphalt Concrete

1. Treatment Guidelines

Conditions For Use

1. Corrugations, slippage cracks, and ravelling may be present.
2. Infrequent settlements and heaves.
3. Other distresses may be high-severity.
4. Widening is contemplated.
5. Realignment is contemplated.
6. Existing profile must be maintained.
7. Extensive utility replacement is necessary.

Constructability

1. Advantages
   a. Uses standard techniques.
   b. Rapid-strength-gaining cement concrete mixes are available.
   c. Traffic can be maintained on initial courses of asphalt concrete.

2. Disadvantages
   a. Overnight and/or long-term lane closures are required for cement concrete pavement.
   b. Must remove and dispose of the existing pavement.

Performance

1. Ride, friction, and structural capacity of a new pavement is realized.
2. Joints and/or cracks must be maintained to achieve desired pavement service life.

Expected Failure Modes

1. Asphalt concrete pavement
   a. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

2. Portland cement concrete pavement
   a. Joint seal failure, joint spalling, blowups, and/or fatigue cracking.

Expected Service Life

1. Asphalt concrete pavement: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Portland cement concrete pavement: 30 years with joint resealing at 8-year intervals.

FLEXIBLE-OVER-RIGID PAVEMENT TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance

Joint and/or Crack Sealing
Joint and/or Crack Filling

Corrective Maintenance

Mill and Patch Joints and/or Cracks
Single-Course Overlay (1" to 1-1/2")
Hot In-Place Recycle (1")
Cold Milling and Replacement (1-1/2")

Rehabilitation

Two-Course Overlay (3")
Cold Milling With Single-Course Overlay (≥ 3")
Hot In-Place Recycle With Single-Course Overlay (3")
Cold In-Place Recycle With Single-Course Overlay (4-1/2")
Multiple-Course Overlay (≥ 4")
Cold Milling With Multiple-Course Overlay (≥ 4")
Cold In-Place Recycle With Multiple-Course Overlay (6")
Remove Flexible Overlay, Crack and Seat With Multiple-Course Overlay (5")
Remove Flexible Overlay, Rubblize With Multiple-Course Overlay (6")

Reconstruction

Full-Depth Portland Cement or Asphalt Concrete

Joint and/or Crack Sealing

1. Treatment Guidelines

Conditions For Use

1. Failed seals or low-severity full-width transverse cracks were never sealed.
2. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
3. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Requires intensive inspection.

Performance

1. Seals out water and incompressibles.
2. Retards development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

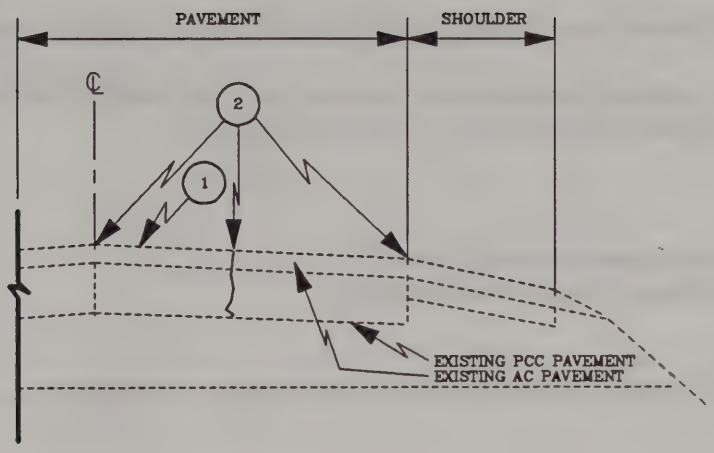
Expected Failure Modes

1. Sealer fails in adhesion or cohesion.

Expected Service Life

5 years.

2. Typical Section



1. Rout, clean, and seal sawed-and-sealed transverse joints and/or full-width transverse cracks.
2. Clean and fill cracks and pavement/shoulder joint.

Joint and/or Crack Filling

1. Treatment Guidelines

Conditions For Use

1. Failed seals or filler or low- and/or medium-severity full-width transverse cracks were never sealed.
2. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
3. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Joints and cracks must be clean for the filler to be effective.

Performance

1. Reduces incompressibles and water infiltration.
2. Retards development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

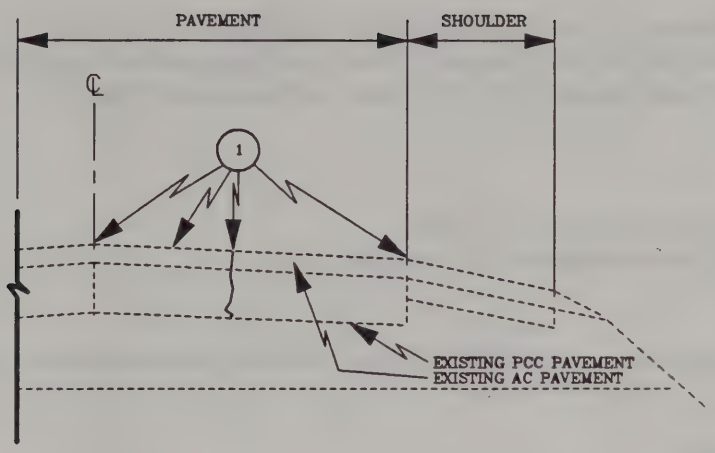
Expected Failure Modes

1. Filler fails in adhesion or cohesion.
2. Wear by traffic.

Expected Service Life

2 years.

2. Typical Section



1. Clean and fill sawed-and-sealed transverse joints, cracks, and pavement/shoulder joint.

Mill and Patch Joints and/or Cracks

1. Treatment Guidelines

Conditions For Use

1. High-severity full-width transverse and/or longitudinal cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
3. Other distresses are generally at the none or low-severity level.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Careful inspection required to match existing pavement elevation.

Performance

1. May improve ride.
2. Prevents water infiltration.
3. Extends pavement service life.

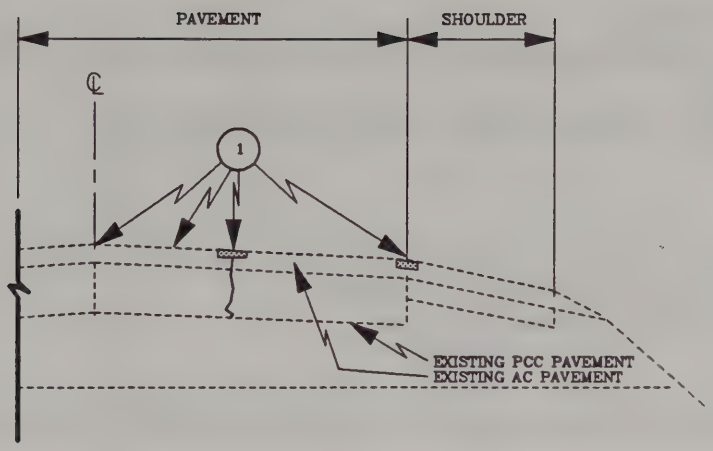
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

5 years.

2. Typical Section



1. Mill high-severity cracks. Tack-coat horizontal and vertical faces and place asphalt concrete patch.

Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, ravelling, and/or high-severity cracking.
3. Medium severity wheelpath rutting and/or widening dropoff.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common rehabilitation techniques.

2. Disadvantages
   a. Crack filling and shimming wheel ruts are required to achieve service life.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes

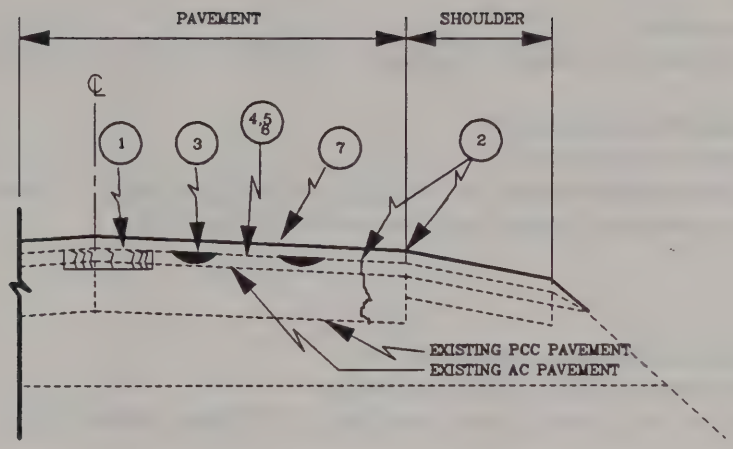
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed joints: 8 years.

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat.
6. Truing-and-leveling.
7. Asphalt concrete top course (1" to 1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Hot In-Place Recycle (1")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent settlements, heaves, slippage cracks, ravelling, and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations may be present.
5. Low- or medium-severity wheelpath rutting and/or widening dropoff.
6. Pavement core evaluation must meet warrants for recycling.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.
   d. Maintains existing profile.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Smoke emissions may prohibit use in residential areas.
   c. Requires some virgin asphalt concrete.

Performance

1. Restores ride, friction, and cross-slope.
2. Improves the longitudinal construction joint.
3. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes

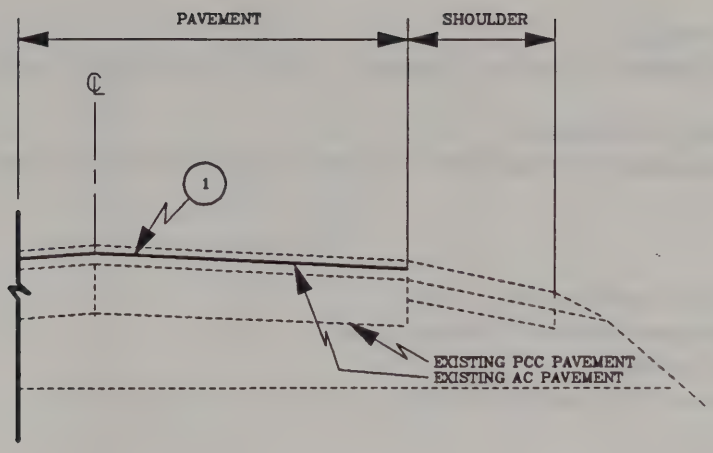
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Hot in-place recycling (1").

   Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from the underlying transverse joints, then new overlay should be sawed and sealed.

Cold Milling and Replacement (1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent settlement, heaves, slippage cracks, ravelling, and/or high-severity cracking.
3. Corrugations may be present.
4. Low- or medium-severity wheelpath rutting and/or widening dropoff.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Maintains existing profile.
   d. Requires no truing-and-leveling.

2. Disadvantages
   a. Must dispose of the millings.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes

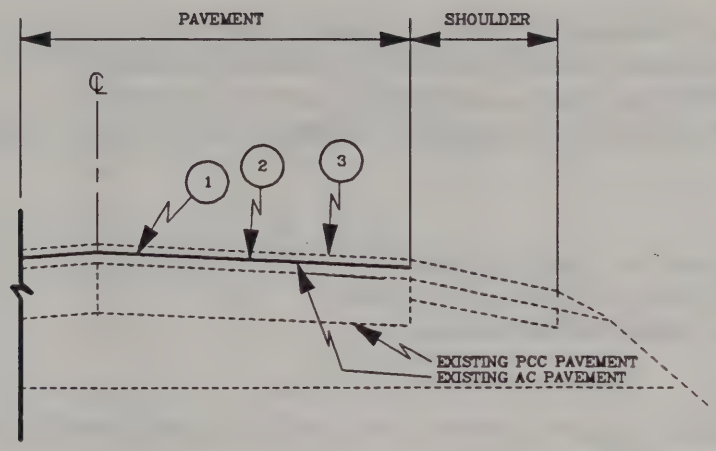
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.

2. Typical Section



1. Cold mill existing pavement surface (1-1/2").
2. Tack coat.
3. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Two-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity full-width transverse cracking and other cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Crack filling, shimming wheel ruts, and truing-and-leveling are required to achieve service life.
   b. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

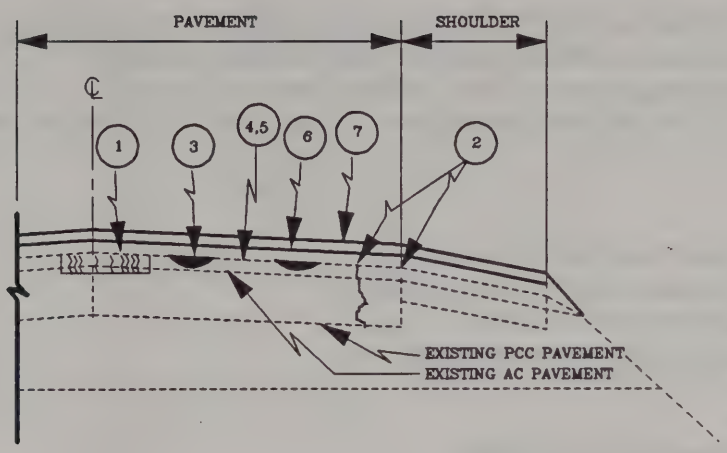
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling course.
6. Asphalt concrete binder course (1-1/2").
7. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Cold Milling With Single-Course Overlay (≥ 3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity full-width transverse cracking and other cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Maintains existing profile.
   d. Requires no truing-and-leveling.

2. Disadvantages
   a. Must dispose of the millings.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

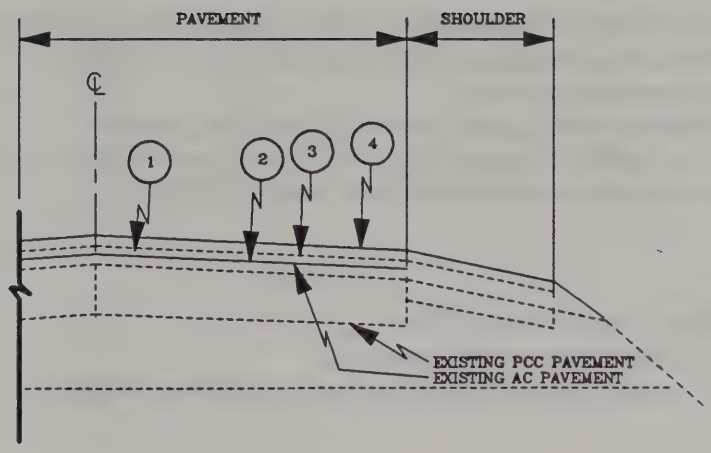
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.

2. Typical Section



1. Cold mill existing pavement surface (≥ 1-1/2").
2. Tack coat.
3. Asphalt concrete inlay course (≥ 1-1/2").
4. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Hot In-Place Recycle With Single-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity full-width transverse cracking and other cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations, slippage cracks, and ravelling may be present.
5. High-severity wheelpath rutting and/or widening dropoff may be present.
6. Pavement core evaluation must meet warrants for recycling.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Smoke emissions may prohibit use in residential areas.
   c. Requires some virgin asphalt concrete.

Performance

1. Restores ride, friction, cross-slope.
2. Improves longitudinal construction joint in the recycled layer.
3. Adds structural capacity.
4. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

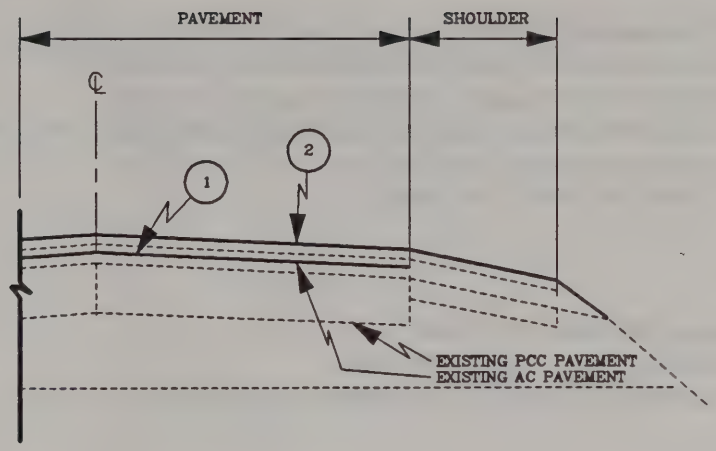
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.

2. Typical Section



1. Hot in-place recycling (1-1/2").
2. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Cold In-Place Recycle With Single-Course Overlay (4-1/2")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity full-width transverse cracking and other cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High severity wheelpath rutting and/or widening dropoff may be present.
5. Pavement core evaluation must meet warrants for recycling.
6. Pavement must have low traffic volume.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no crack sealing or shimming wheel ruts.

2. Disadvantages
   a. Manholes or drainage units will damage recycling equipment.
   b. Truing-and-leveling may be required.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

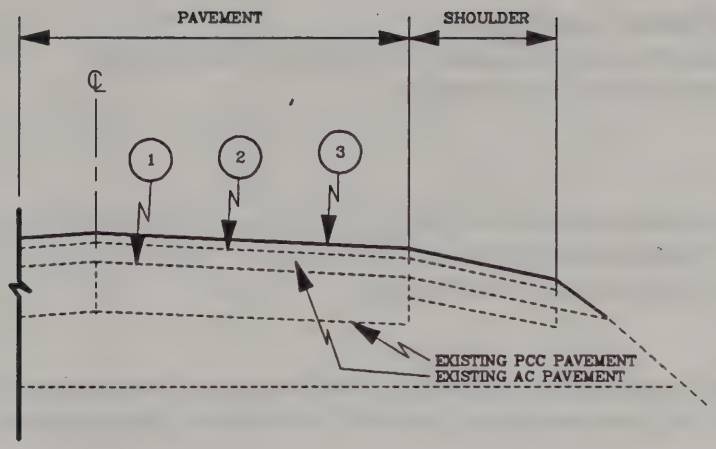
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.

2. Typical Section



1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Multiple-Course Overlay (≥ 4")

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Requires crack filling, shimming wheel ruts, and truing-and-leveling.
   b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

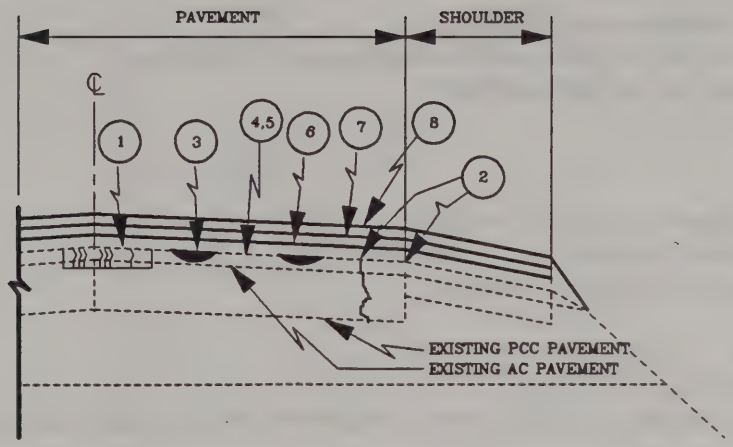
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling course.
6. Asphalt concrete strengthening course (1" to 4").
7. Asphalt concrete binder course (1-1/2").
8. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Cold Milling With Multiple-Course Overlay (≥ 4")

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no truing-and-leveling.

2. Disadvantages
   a. Must dispose of millings.
   b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

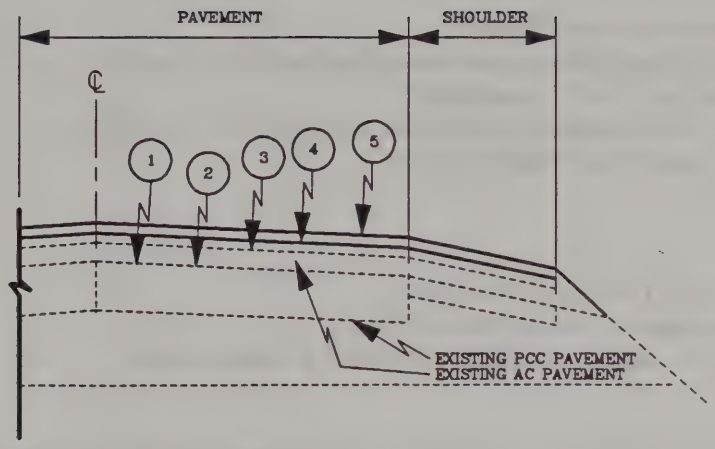
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.

2. Typical Section



1. Cold mill existing pavement surface (≥ 1").
2. Tack coat.
3. Asphalt concrete inlay and/or strengthening course (≥ 1"), multiple-course required for lifts >4".
4. Asphalt concrete binder course (1-1/2").
5. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Cold In-Place Recycle With Multiple-Course Overlay (6")

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.
4. Pavement core evaluation should meet warrants for recycling.
5. Pavement must have low traffic volume.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no crack sealing or shimming wheel ruts.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Truing-and-leveling may be required.
   c. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

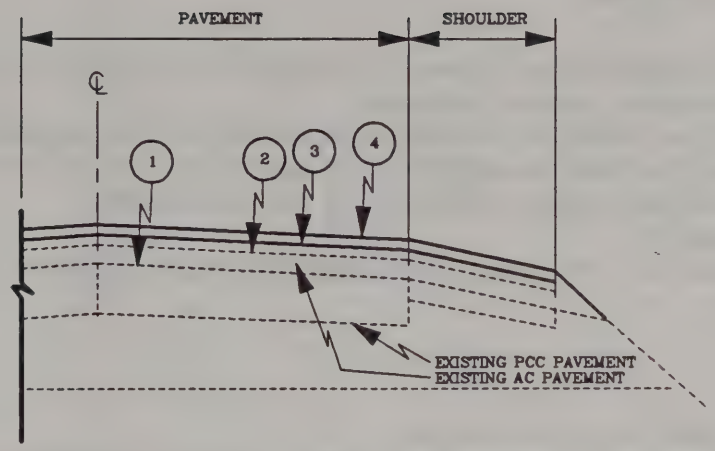
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.

2. Typical Section



1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete binder course (1-1/2").
4. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Remove Flexible Overlay, Crack and Seat With Multiple-Course Overlay (5")

1. Treatment Guidelines

Conditions For Use

1. Medium- and/or high-severity full-width transverse, longitudinal, and edge cracking.
2. Infrequent settlements, heaves, blowups.
3. Slab cracks and/or infrequent separated transverse and/or longitudinal joints have reflected through the flexible overlay and caused medium- and high-severity cracks.
4. Corrugations, slippage cracks, and ravelling may be present.
5. Utilities not present.
   (Note: Distresses in 2 are repaired by replacing segments with asphalt concrete before overlay.)

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Traffic can be maintained on the cracked-and-seated portland cement concrete pavement.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Cracking and seating may create additional unexpected spalls.
   b. Has potential to disrupt culverts and underground utilities.
   c. 5" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Asphalt concrete overlay
   a. Restores ride, friction, cross-slope.
   b. Increased thickness adds structural capacity and bridges patched spalls.

2. Crack and seat
   a. Minimizes reflection cracking.
   b. Absence of reflection cracks keeps water from pavement structure.
   c. Crack filling may be necessary to achieve desired overlay service life.

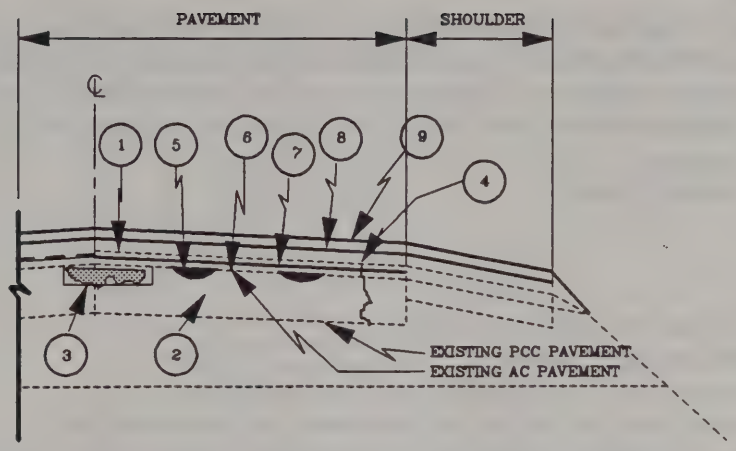
Expected Failure Modes

1. Oxidation, ravelling, and/or rutting.
2. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.
3. Failure to maintain reflection cracks may lead to multiple cracks and potholes.
4. Full-depth asphalt concrete repairs may rut, shove, and heave causing local premature failure.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Remove existing asphalt concrete overlay.
2. Crack and seat existing concrete pavement.
3. Mill and patch spalls with asphalt concrete.
4. Clean and fill joints and cracks.
5. Shim faults and wheel ruts.
6. Clean pavement, tack coat, truing-and-leveling.
7. Initial asphalt concrete course (2").
8. Asphalt concrete binder course (1-1/2").
9. Asphalt concrete top course (1-1/2").

Remove Flexible Overlay, Rubblize With Multiple-Course Overlay (6")

1. Treatment Guidelines

Conditions For Use

1. Medium- and/or high severity full-width transverse, longitudinal, and edge cracking.
2. Corrugations, settlements, heaves, slippage cracks, and ravelling may be present.
3. Slab cracks and/or separated transverse and/or longitudinal joints have reflected through the flexible overlay and caused medium- and high-severity cracks.
4. Utilities are present.
5. Widening is contemplated.

Constructability

1. Advantages
   a. Can be done one lane at a time.
   b. Does not damage utilities.
   c. Compaction and overlay use standard techniques.
   d. Spall repair and full-depth replacement are not necessary.
   e. Pavement widening, shoulder replacement, and filling depressions can be accomplished with crushed stone that is compatible with rubblized pavement.

2. Disadvantages
   a. Traffic cannot be maintained on a rubblized surface until the initial asphalt concrete course is placed.
   b. Positive drainage is required.
   c. 6" thickness may be a problem for vertical clearance and appurtenances.
   d. Most roadway features will require adjustment.
   e. Lane closure may be required for extended periods.
   f. Rubblizing equipment cannot get closer than 3 ft to curbs.

Performance

1. Restores ride, friction, cross-slope.
2. Eliminates reflection cracks.
3. Absence of reflection cracks keeps water from the pavement structure.
4. Rubblized pavement provides a drainage layer.

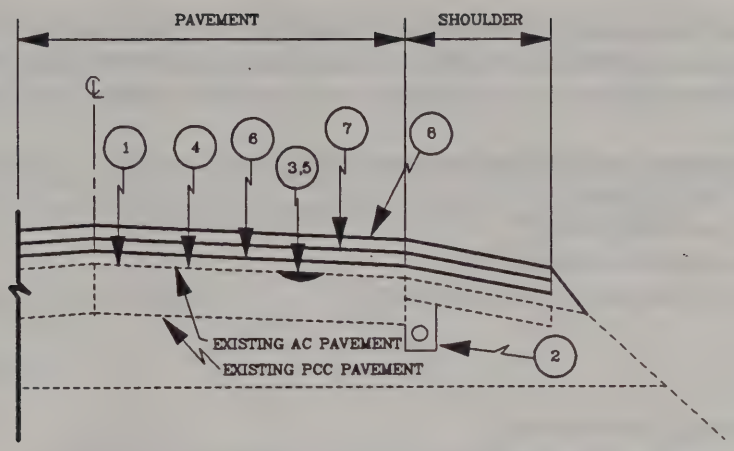
Expected Failure Modes

1. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Remove existing asphalt concrete overlay.
2. Install underdrain.
3. Remove asphalt patches.
4. Rubblize and compact existing concrete pavement.
5. Patch depressions with crushed stone.
6. Initial asphalt course: asphalt concrete base (3").
7. Asphalt concrete binder course (1-1/2").
8. Asphalt concrete top course (1-1/2").

Note: An alternative to underdrain installation is a daylighted crushed stone shoulder replacing the existing shoulder.

Full-Depth Portland Cement or Asphalt Concrete

1. Treatment Guidelines

Conditions For Use

1. Medium- and/or high-severity full-width transverse, longitudinal, and edge cracking.
2. Slab cracks and/or a significant number of separated transverse and/or longitudinal joints have reflected through the flexible overlay and caused medium- and high-severity cracks.
3. Blowups, settlements, and/or heaves may exist.
4. Widening is contemplated.
5. Realignment is contemplated.
6. Existing profile must be maintained.
7. Extensive utility replacement is necessary.

Constructability

1. Advantages
   a. Uses standard techniques.
   b. Rapid-strength-gaining cement concrete mixes are available.
   c. Interim traffic can be maintained on the initial courses of asphalt concrete.

2. Disadvantages
   a. Overnight and/or long-term lane closures are required for cement concrete pavement.
   b. Must remove and dispose of the existing pavement.

Performance

1. Ride, friction, and structural capacity of a new pavement is realized.
2. Joints and/or cracks must be maintained to achieve the desired pavement service life.

Expected Failure Modes

1. Asphalt concrete pavement
   a. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

2. Portland cement concrete pavement
   a. Joint seal failure, joint spalling, blowups, and/or fatigue cracking.

Expected Service Life

Asphalt concrete pavement: 15 years with full-width transverse crack sealing at 5-year intervals.

Portland cement concrete pavement: 30 years with joint resealing at 8-year intervals.

RIGID, FLEXIBLE, OR FLEXIBLE-OVER-RIGID PAVEMENT WIDENING TREATMENT GUIDELINES AND TYPICAL SECTIONS

Portland Cement Concrete

Asphalt Concrete

Portland Cement Concrete

1. Treatment Guidelines

Conditions For Use

1. Settlements, heaves, blowups, and slab cracking do not exist or have been repaired by full-depth segment replacement.
2. Other distresses are at the none or low-severity level.
3. Cores of existing concrete pavement show no cracking or mortar deterioration and adequate compressive strength. Cores are necessary at the widening edge to ensure that longitudinal joint ties will bond and tie.

Constructability

1. Advantages
   a. No overnight lane closures required, if excavation amount equals replacement within the work day and rapid-setting concrete is used.
   b. Common construction materials and techniques.

2. Disadvantages
   a. Drill for longitudinal tie holes needs a 3-ft wide excavation to operate.

Performance

1. Matching thickness, widening will provide structural capacity similar to the existing pavement.
2. Joint sealing needed to achieve widening service life.

Expected Failure Modes

1. Sealing
   a. Seals fail in adhesion or cohesion.

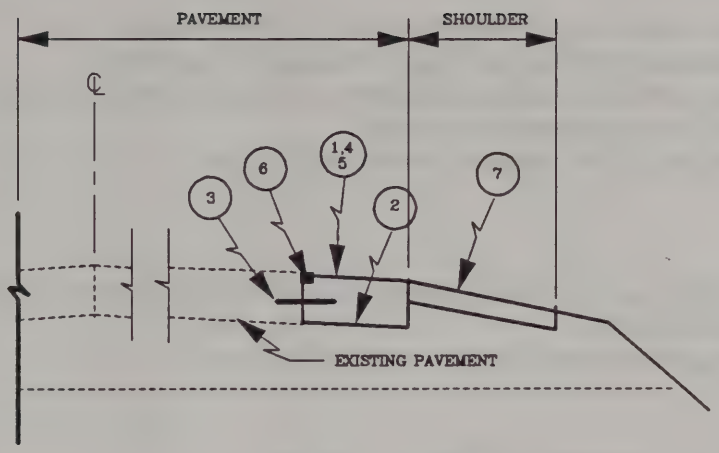
2. Widening
   a. Fails in same manner as any cement concrete pavement.

Expected Service Life

1. Joint sealing: 8 years.

2. Widening: equals or exceeds existing pavement service life up to 30 years.

2. Typical Section



1. Excavate and remove existing shoulder, widen embankment and subbase, etc.
2. Replace disturbed subbase and compact.
3. Drill holes and install longitudinal joint ties.
4. Place transverse load-transfer devices.
5. Place new concrete.
6. Construct and seal longitudinal and transverse joints.
7. Construct new shoulder.

Note: If flexible-over-rigid pavement is being widened, the cement concrete and asphalt concrete pavements are matched in thickness. Joints in the asphalt concrete are sealed in the same manner as those in the existing pavement.

Asphalt Concrete

1. Treatment Guidelines

Conditions For Use

1. Settlements and heaves do not exist or have been replaced.
2. Full-width transverse cracking or edge cracking do not exist.
3. Cores of existing overlaid cement concrete pavement show cracking, mortar deterioration, or low compressive strength.
4. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
   a. No overnight lane closures required, if excavation amount equals replacement within the workday.
   b. Common construction materials and techniques.

2. Disadvantages
   a. Narrow-width widening difficult to compact.

Performance

1. Widening has structural capacity similar to the existing pavement, when pavement and subbase thicknesses are matched.
2. Longitudinal joint between the widening and existing pavement must be sealed to achieve expected service life.

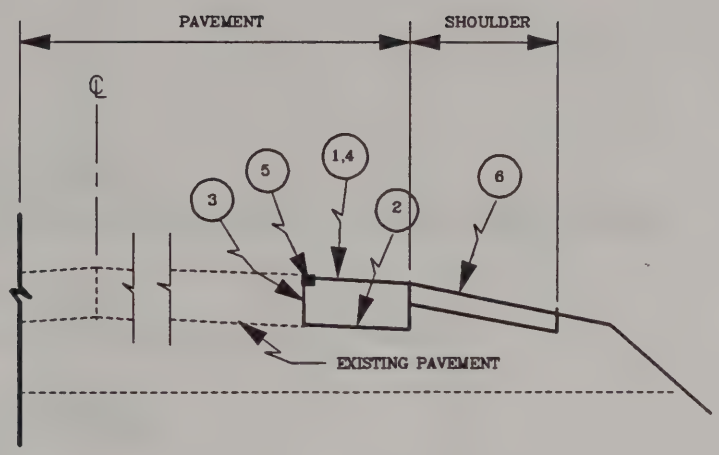
Expected Failure Modes

1. Seals fail in adhesion or cohesion.
2. Pavement/widening longitudinal joint separation.
3. Water infiltration weakens subbase, causing widening dropoff, multiple cracking, and potholes.
4. Fails in same manner as any flexible pavement.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Excavate and remove existing shoulder, widen embankment and subbase, etc.
2. Replace disturbed subbase and compact.
3. Tack-coat existing pavement edge.
4. Place and compact asphalt concrete.
5. Rout and seal longitudinal joint.
6. Construct new shoulder.

Note: If no subbase exists, a minimum 8" subbase should be placed under the new widening. If open base is encountered in the existing pavement, widen only with open base.

FLEXIBLE SHOULDER TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance
Pavement/Shoulder Joint and/or Crack Filling

Corrective Maintenance
Asphalt Concrete Wedging
Surface Treatment

Rehabilitation
Single- or Multiple-Course Asphalt Overlay

Reconstruction
Shoulder Replacement With Cement Concrete, Asphalt Concrete, or Bituminous-Stabilized Gravel

Pavement/Shoulder Joint and/or Crack Filling

1. Treatment Guidelines

Conditions For Use

1. Failed filler, or joints and cracks never filled.
2. Pavement/shoulder separation is at the medium-severity level.
3. Deterioration, consisting of a single crack, is at the low-severity level.
4. Other distresses are at the none or low-severity level or are infrequent.

Constructability

1. Advantages
    a. Overnight lane closure not required.

Performance

1. Prevents water infiltration from weakening the base, thus retarding development of additional distress.

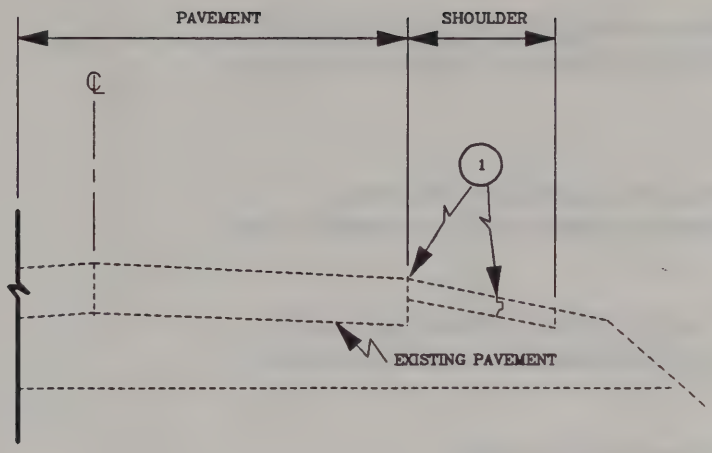
Expected Failure Modes

1. Filler fails in cohesion or adhesion.

Expected Service Life

2 years.

2. Typical Section



1. Clean and fill cracks and pavement/shoulder joint.

Asphalt Concrete Wedging

1. Treatment Guidelines

Conditions For Use

1. Medium or high-severity lane shoulder dropoff.
2. Other distresses at the none or low-severity level.

Constructability

1. Advantages
   a. Overnight lane closures not required.
   b. Can be done by closing only one traffic lane.

2. Disadvantages
   a. Pavement edge profile difficult to match.
   b. Compaction difficult due to roller bridging.

Performance

1. Eliminates pavement edge hazard.

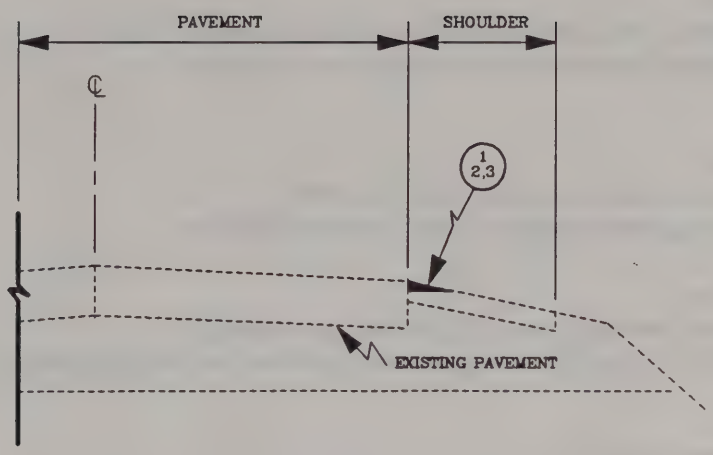
Expected Failure Modes

1. Cracking, separation, and ravelling.

Expected Service Life

3 years.

2. Typical Section



1. Clean shoulder.
2. Tack coat.
3. Asphalt concrete wedging.

Surface Treatment

1. Treatment Guidelines

Conditions For Use

1. Multiple-crack deterioration at the medium-severity level.
2. Pavement/shoulder separation may also be present.

Constructability

1. Advantages
   a. Overnight lane closures not required.
   b. Can be done by closing only one traffic lane.

2. Disadvantages
   a. Difficult working next to barrier or guiderail.
   b. Shoulder should be wedged and patched as needed before surface treatment.

Performance

1. Retards deterioration.

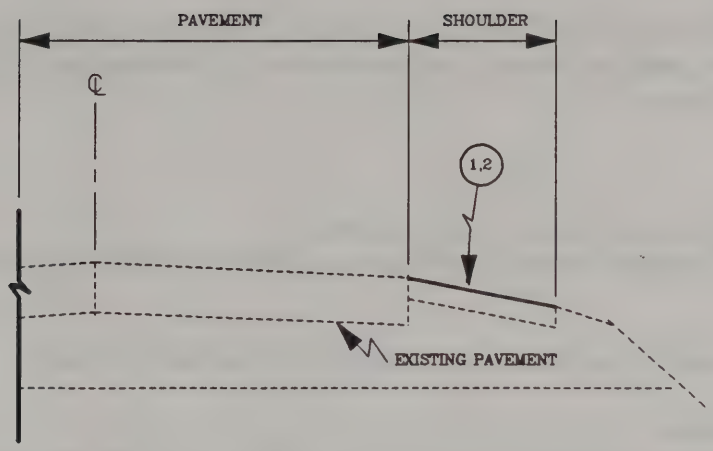
Expected Failure Modes

1. Cracking, separation, surface oxidation, stone loss from plows and ravelling.

Expected Service Life

5 years.

2. Typical Section



1. Clean shoulder.
2. Single surface treatment.

Note: May require asphalt concrete wedging as a pretreatment.

Single- or Multiple-Course Asphalt Overlay

1. Treatment Guidelines

Conditions For Use

1. Roadway condition dictates an asphalt overlay. Shoulder may be repaired by carrying same-thickness overlay across it, or reconstructing the shoulder. Shoulder condition dictates this choice.

Constructability

1. Advantages
   a. Overnight lane closures not required.
   b. Can be done at same time with same items as roadway paving.

Performance

1. Depends on overlay thickness and condition of existing shoulder.

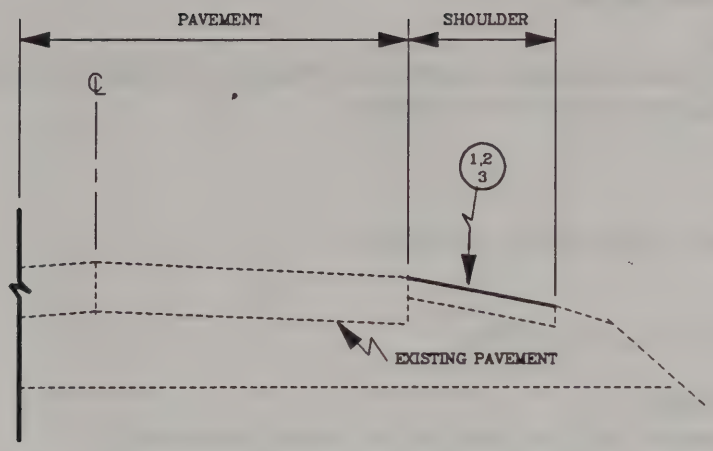
Expected Failure Modes

1. Asphalt oxidation, ravelling, and pavement/shoulder joint cracking.

Expected Service Life

1. Single course: 8 years
2. Multiple course: 15 years

2. Typical Section



1. Clean shoulder.
2. Tack coat.
3. Single- or multiple-course asphalt overlay.

Note: May require asphalt concrete wedging as a pretreatment.

Shoulder Replacement With Cement Concrete, Asphalt Concrete, or Bituminous-Stabilized Gravel

1. Treatment Guidelines

Conditions For Use

1. High-severity deterioration consisting of multiple cracks and potholes.
2. General shoulder deformation present.

Constructability

1. Advantage
    a. Common construction technique.

Performance

1. Provides life of a new shoulder.

Expected Failure Modes

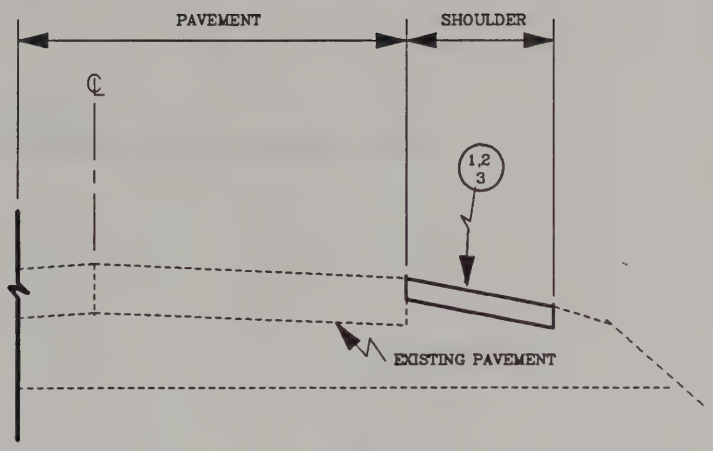
1. Cement concrete (only adjacent to concrete pavement)
    a. Pavement/shoulder joint sealant failure, water infiltration, and cracking.

2. Asphalt concrete or bituminous-stabilized gravel with asphalt concrete top course
    a. Asphalt oxidation, ravelling, cracking, separation, and dropoff.

Expected Service Life

1. Cement concrete: 30 years
2. Asphalt concrete: 15 years
3. Bituminous stabilized gravel with asphalt concrete top course: 15 years.

2. Typical Section



1. Reconstruct with portland cement concrete (if adjacent pavement is concrete, then concrete shoulder tapers from 9" to 6")
2. Reconstruct with asphalt concrete (3" or 4").
3. Reconstruct with bituminous-stabilized gravel (3") and asphalt concrete top course (1").

PART 3: LIFE-CYCLE-COST ANALYSIS

PART 3: LIFE-CYCLE-COST ANALYSIS

Once initial treatment alternatives have been identified, one must choose among them. One method used to determine the most cost-effective is a life-cycle-cost (LCC) analysis. LCC can be defined as all Department costs necessary to provide a serviceable pavement over a particular analysis period. Its components include current treatment costs; the cost, timing, and service lives of future maintenance and rehabilitation treatments; the time value of money; and the residual or salvage value.

An LCC analysis will identify the least expensive alternative over time. It should be emphasized that this is only one step in the decision-making process. Budgetary constraints, non-pavement construction needs, and heavy traffic volumes also may influence treatment selection.

An LCC analysis has the following steps:

1. Identify all appropriate initial treatment alternatives.
2. Determine the analysis period and treatment strategy for each alternative.
3. Calculate the cost of each treatment strategy.
4. Compare treatment strategies using the Present Worth method.
5. Perform a sensitivity analysis.
6. Select the best treatment strategy based on LCC and other factors.

Identify Initial Treatment Alternatives

Distress Data Forms, completed according to the procedures described in this Manual's Volume I, must be reviewed. Distress information in those forms is compared with the "Conditions For Use" in Part 2 ("Treatment Guidelines and Typical Sections") of this Manual. A treatment is identified as an alternative if information in the Distress Data Form and Conditions For Use are similar. Some treatments may be eliminated due to specific characteristics of the project. Regional or Main Office Soil Mechanics Bureau and Materials Bureau personnel should be consulted.

Conditions For Use cannot include all possible combinations of distresses encountered in the field. Actual distress types and severities may apply to Conditions For Use of several treatments. When this occurs, all treatments in question should be considered as alternatives. All Conditions For Use do not have to be met for a treatment to be considered as an alternative. Similarly, a treatment may be an appropriate alternative even if the recorded distress data slightly exceed the Conditions For Use. Conditions For Use simply represent an approximate distress condition under which a particular treatment is considered effective.

For example, consider the pavement in Area I of the Model Pavement Evaluation (Part 4). The Distress Data Form for this pavement is found on page B-3. It shows that the primary pavement distresses encountered are full-width transverse and longitudinal cracking of medium and high severity. As noted in the "Remarks" column, these cracks appear over underlying PCC joints. The shoulders exhibit medium-severity lane/shoulder separation and low- to medium-severity lane/shoulder dropoff.

The Distress Data Form information is then compared with the "Conditions For Use" of treatments listed in the flexible/rigid treatment guidelines. Several treatments have Conditions For Use similar to the recorded distress data: Mill and Patch Joints and/or Cracks, Two-Course Overlay (3"), Cold Milling and Replacement (≥ 3"), Hot In-Place Recycle with Single-Course Overlay (2-1/2"), Cold In-Place Recycle with Single-Course Overlay (4-1/2"), Cold In-Place Recycle with Multiple-Course Overlay (6"), Multiple-Course Overlay (≥ 4"), and Cold Milling with Multiple-Course Overlay (≥ 4"). Treatments involving cold milling and recycling were eliminated because the overlay was in good condition except over PCC joints. Complete removal was thus considered unnecessary. The Materials Engineer cored the pavement and determined that mix properties of the existing overlay were acceptable for an overlay base. By itself, Mill and Patch Joints and/or Cracks was not considered an alternative because the overlay had exceeded its expected service life. However, this treatment would be (and in this example is) appropriate for use in conjunction with another rehabilitation treatment. By process of elimination, the preferred alternatives were Two-Course Overlay (3") and Multiple-Course Overlay (≥ 4").

Determine The Analysis Period And Treatment Strategy For Each Alternative

The analysis period is the time over which costs of alternative treatment strategies are compared. A treatment strategy consists of the initial treatment alternative and its expected future maintenance and rehabilitation needs. The period must be long enough to include the entire service life of at least one rehabilitation treatment.

Expected future maintenance and rehabilitation needs must be considered when developing an analysis period. Typically, several preventive maintenance treatments and one or two rehabilitation treatments are included in an analysis period. One rehabilitation treatment should be scheduled at or near the end of the initial treatment's service life. Preventive maintenance should be scheduled at regular intervals before rehabilitation, and during the service life of the rehabilitation treatment. Preventive maintenance timing is based on that service life.

For example, again consider Area I of the Model Pavement Evaluation. The initial treatment alternatives identified are Two-Course Overlay (3") and Multiple-Course Overlay (≥ 4"). Based on experience, the evaluation's author chose the following future treatment sequences, where "year" is the total years after overlay:

Two-Course Overlay (3")

Year	Activity
2	Fill longitudinal cracks at centerline and pavement/shoulder joint (30% of total).
4	Same as year 2
6	Same as year 2
8	Fill sawed and sealed joints (100% of total), longitudinal cracks at centerline, and pavement/shoulder joint (30% of total).
10	Same as year 8
12	Mill and patch, fill remaining cracks, two-course overlay (3"), saw and seal transverse joints.
14	Same as year 2
16	Same as year 2
18	Same as year 2
20	Same as year 8
22	Same as year 8
24	Same as year 8
26	Same as year 8
27	Cold mill and replace 1-1/2" AC top course, saw and seal transverse joints.
29	Fill longitudinal cracks at centerline and pavement/shoulder joint (40% of total).
30	End

Multiple-Course Overlay (≥ 4")

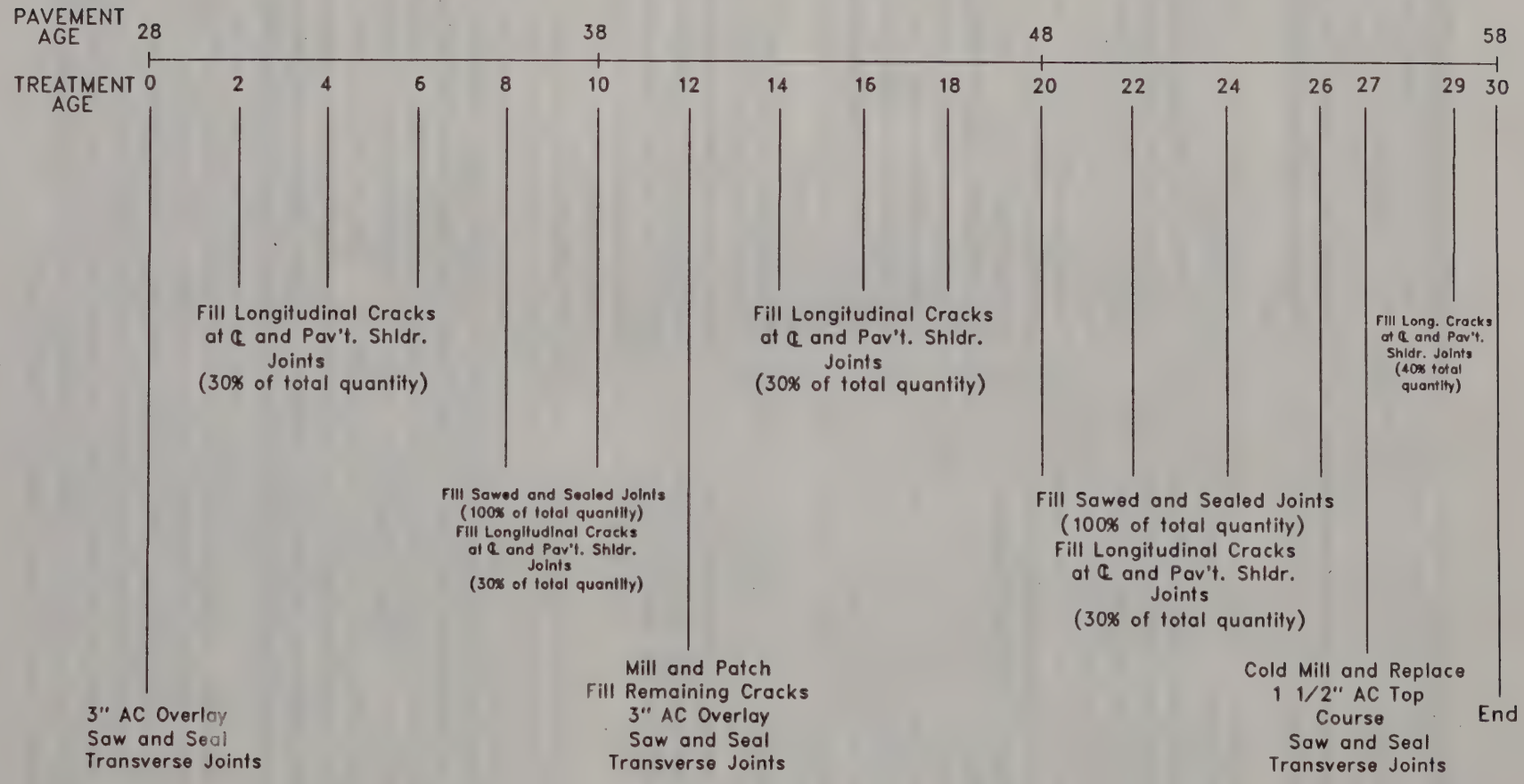
Year	Activity
2	Fill longitudinal cracks at centerline and pavement/shoulder joint (20% of total).
4	Same as year 2
6	Same as year 2
8	Fill sawed and sealed joints (100% of total), longitudinal cracks at centerline, and pavement/shoulder joint (20% of total).
10	Same as year 8
12	Same as year 8
14	Same as year 8
15	Mill and patch, fill remaining cracks, two-course overlay (3"), saw and seal transverse joints.
17	Fill longitudinal cracks at centerline and pavement/shoulder joint (30% of total).
19	Same as year 17
21	Same as year 17
23	Fill sawed and sealed joints (100% of total), longitudinal cracks at centerline, and pavement/shoulder joint (20% of total).
25	Same as year 23
27	Same as year 23
29	Same as year 23
30	End

The author believes the multiple-course overlay will last slightly longer than the two-course overlay; respective service lives of 15 and 12 years were assigned. Also, more maintenance is anticipated for the thinner overlay before future rehabilitation. The preventive maintenance treatment of filling longitudinal cracks is completed every 2 years on both overlays, but more is required on the two-course overlay. The author also considered the recommended 8-year service life of sawed-and-sealed transverse joints in asphalt concrete overlays over portland cement concrete pavement. These joints are filled as part of preventive maintenance treatment beginning after 8 years and until rehabilitation.

The author predicted that at the ends of their service lives both overlay alternatives would require a two-course overlay as a rehabilitation treatment. A service life of 15 years is assigned to the two-course overlay rehabilitation treatment in both alternatives. The same service life was assigned because it was believed that the initial treatments would be in about the same condition at the end of their respective service lives. Identical preventive maintenance sequences are assumed after rehabilitation: fill cracks at 2-year intervals and fill sawed-and-sealed joints at 2-year intervals after 8 years.

FIGURE 1
TWO-COURSE OVERLAY ANALYSIS PERIOD TIME LINE

AREA I



SALVAGE VALUE

1 1/2" AC Overlay – 5 Years
Saw and Seal Joints – 5 Years
Fill Cracks and Joints – 1 Year

The minimum analysis period is the longest expected service life of the initial treatment and one rehabilitation treatment for each alternative treatment strategy considered. In this case the multiple-course overlay with one rehabilitation treatment has an expected service life of 30 years, with 27 years for the two-course overlay with one rehabilitation treatment. The minimum analysis period for these alternatives thus is 30 years. To make the analysis periods of the alternatives equal, another treatment must be applied to the two-course overlay after 27 years. Cold Milling and Replacement (1-1/2") was chosen. It is very possible that this will not be the required treatment in 27 years, but it is included to help make a better current decision by accounting reasonably for an anticipated future need. A pavement evaluation before rehabilitation in the 12th year will more accurately predict treatment needs after 27 years.

Cold Milling and Replacement (1-1/2") has an expected service life of 8 years. After 30 years only 3 years of service life have been used, with 5 years remaining. Similarly, Sawed and Sealed Joints (8-year service life) and Filling Cracks and Joints (2-year service life) have 5 and 1 years of unused service life remaining, respectively. In the multiple-course overlay treatment strategy, only Filling Cracks and Joints has remaining service life (1 of 2 years). Remaining service lives will be accounted for as residual or salvage value when costs are calculated.

When treatment strategy alternatives have been decided, they are placed on an analysis period time-line, as shown in Figures 1 and 2. It is beyond the scope of this Manual to prescribe a standard maintenance and rehabilitation sequence for each initial treatment. Regional preferences, site-specific factors, work history, climate, and traffic affect type and timing of future treatments. Sound, consistent future treatment strategies can be developed using individual and regional experience and the treatment service lives given in Part 2 (Treatment Guidelines) of this manual. Service lives given are not absolute and may be varied based on local experience.

A pavement's actual future needs may not coincide with the predicted future strategy. Anticipating future treatments serves two purposes: planning work needs within a pavement management system, and helping the user choose the most cost-effective initial treatment alternative. The more accurately that future needs are predicted, the better both purposes are served. After initial treatments, actual maintenance and rehabilitation needs should be compared to what was predicted. Comparisons of this type allow refinement of treatment strategies and more cost-effective decision-making. Readers are encouraged to develop their own sound treatment strategies and time-lines based on their experience.

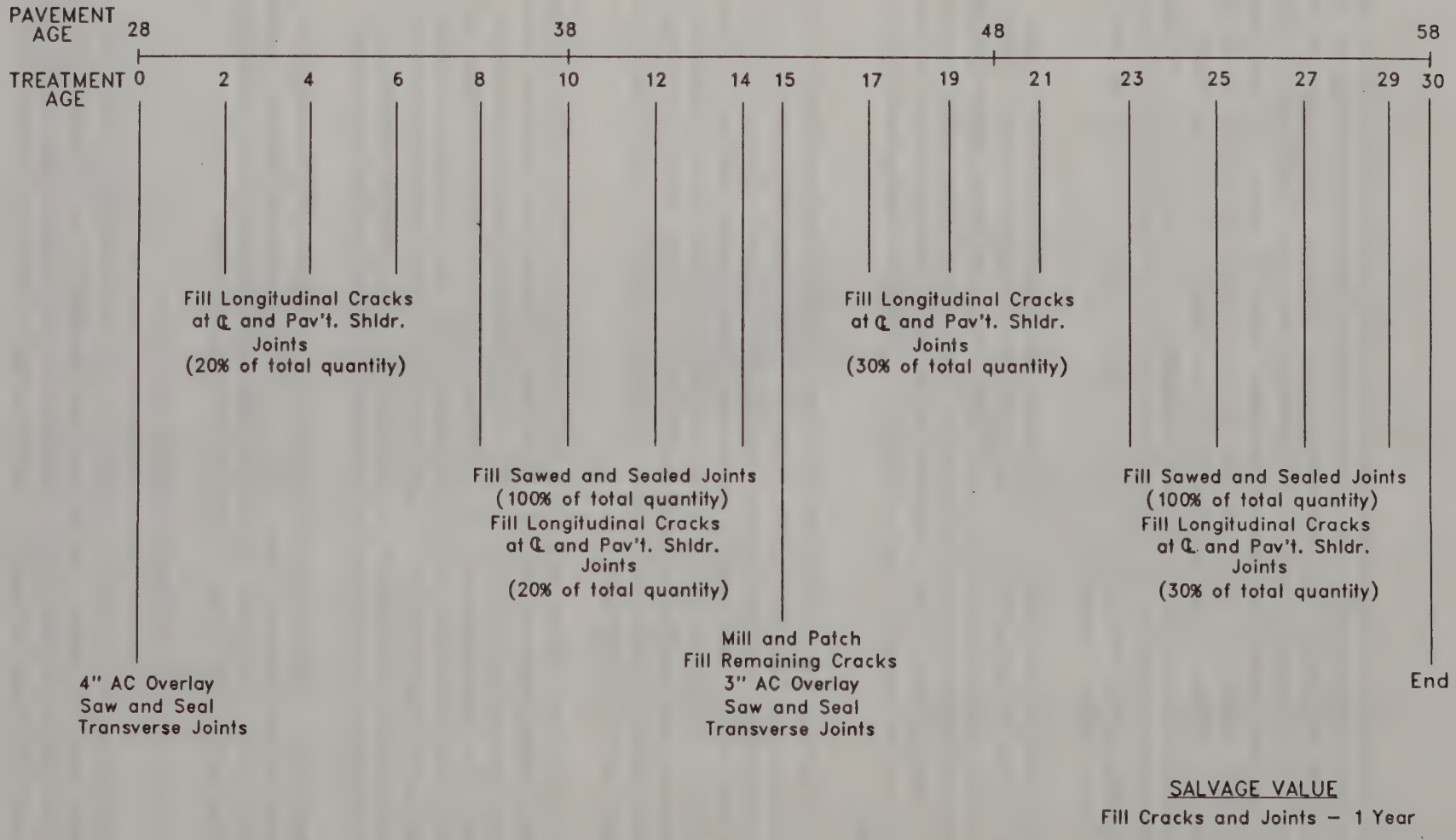
It is possible that only one initial treatment alternative will be identified based on information in the Distress Data Form. A future treatment strategy should still be developed to plan work needs. This would also allow comparisons of predicted and actual needs to aid in developing future strategies on other projects.

Calculate Cost Of Each Treatment Strategy Alternative

After all treatments within each treatment strategy have been identified and located on the appropriate time-line, current cost of each must be determined. This may be estimated by either of two methods accounting for quantities and prices of all items required to complete the treatment. Regions normally use the Preliminary Estimating Program (PEP), generally

FIGURE 2
MUTIPLE–COURSE OVERLAY ANALYSIS PERIOD TIME LINE

AREA I



SALVAGE VALUE

Fill Cracks and Joints – 1 Year

the responsibility of the Regional Estimating Engineer, and its "operations breakdown" concept. The second option is to determine quantities and costs of all specific items required to complete the treatment. In either case, regional planners/designers should estimate the cost of each treatment separately, using the same method as for other regional projects.

For an example, consider the 3" and 4" AC overlays described earlier. Tables 1 and 2 give respective overlay costs calculated by determining quantities and costs of the required items. These tables contain item numbers, brief item descriptions, pay units, unit costs, per-mile quantities, and individual item costs (unit costs x per-mile quantities). Total item cost is the sum of individual item costs. Required items for treatments are found in Part 2 ("Treatment Guidelines and Typical Sections"). The Department's Standard Specifications: Construction and Materials and a listing titled "Pavement Restoration Techniques," which is issued as an Engineering Instruction, may also be helpful in identifying necessary items. Item costs may be obtained from the Department's Weighted Average Bid Prices or the Bid Analysis Management System (BAMS). Per-mile quantities calculations are based on types and amounts of distresses recorded on the Distress Data Forms.

Overhead factors are then applied to the total item cost. These consist of variable percentages for surveying, maintenance and protection of traffic, mobilization, preliminary engineering, and construction inspection. When calculating costs for surveying, maintenance and protection of traffic, and mobilization the percentages are compounded. Percentages for preliminary engineering and construction inspection are not compounded in the total cost computation. The method used to apply these factors can be found in Tables 3 and 4. Note that no factors are used for contingencies, as information from the pavement evaluation eliminates the need for this estimate.

Tables 3 and 4 contain PEP output sheets for the same alternatives. Note that general operations are identified, not specific items. For example, the operation "Pavement-Existing, Overlay" automatically provides for asphalt concrete, tack coat, and cleaning existing pavement. Similarly, to approximate the cost of edge drains, the operation "Underdrain" provides trench/culvert excavation, piping, and filter. Item-specific operations, such as Shoulder Backup or AC and PCC Joint Repair, not noted in the standard PEP format may be added as "Lump Sum Specials" or "Regional Specials." All items listed in Part 2 of this Manual ("Treatment Guidelines and Typical Sections") must be accounted for in either general operations or lump sum or regional specials.

The PEP calculates operation costs based on a region's historical costs for items included in the specified operations. Further, when the Summary Options Sheet (part of PEP) is selected, costs (based on default percentages) may be added for survey, maintenance and protection of traffic, mobilization, contingencies, preliminary engineering, construction inspection, etc. All costs selected by the program, including those percentages for Survey, etc., may be adjusted based on planner/designer/estimator judgment and experience.

Total costs used in this example do not reflect such items as non-pavement excavation, clearing, sidewalks, curbs, guiderails, drainage units, signing, landscaping, etc. These non-pavement items are considered equal for these alternatives. It is commonly acceptable to exclude equal, non-pavement items from a LCC analysis. In some analyses, however, some non-pavement items may not be equal for the alternatives considered.

TABLE 1: COSTS OF AREA I, TWO-COURSE OVERLAY SPECIFIC ITEMS

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
203.02	Shoulder Excavation	C.Y.	$ 6.00	1,760	$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	293	4,102
403.13	Dense Binder (1 1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1 1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal (deep sawcuts may not be required)	L.F.	5.00	2,640	13,200
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07	Clean & Fill Jts./Crks. (this item may not be required)	L.S.(L.F.)	0.50(L.F.)	7,392	3,696
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	271,116
	Overhead Factors (Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%) (See Tables 3 and 4 for calculations)				92,613
				Total Cost/Mile	363,729
				Total Cost Area I	$727,458

TABLE 2: COSTS OF AREA I, MULTIPLE-COURSE OVERLAY SPECIFIC ITEMS

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
203.02	Shoulder Excavation	C.Y.	$ 6.00	1,760	$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	391	5,474
403.13	Dense Binder (1 1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1 1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
403.21	Truing & Leveling (1") (pav't & shldrs.)	Ton	34.00	1,117	37,978
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal	L.F.	5.00	2,640	13,200
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07 (this item may not be required)	Clean & Fill Jts./Crks.	L.S.(L.F.)	0.50(L.F.)	7,392	3,696
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	310,466
Overhead Factors (Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%) (See Tsbles 3 and 4 for calculations)					106,055
				Total Cost/Mile	416,521
				Total Cost Area I	$833,042

TABLE 3: COSTS OF TWO-COURSE OVERLAY OPERATIONS

PRELIMINARY ESTIMATE PROGRAM

PREPARED BY:_____
DATE:_____

PROJECT IDENTIFICATION NUMBER: 1234.57
PROJECT ESTIMATE PHASE:
TYPE OF CONSTRUCTION: 1- R-P TWO COURSE OVERLAY

PRESENT COST
$ 303,126.97

CHECKED BY:_____
DATE:_____

PRINT OUT OF PRELIMINARY ESTIMATE FOR PIN NO. 1234.57
PROJECT DESCRIPTION TWO COURSE OVERLAY

DATE: 08/22/91
TIME: 11:06:47 PAGE 1

OPERATION	QUANTITY	UNIT	COST	BREAKDOWN	UNIT	REFNO.	PRICE	FACTOR
EARTHWORK								
EARTHWORK								
EXCAVATION - EARTH	1760.0	CY	10560.00	UNCL EXCAVATION	CY	1	6.00	1.00000
PAVEMENT EXISTING								
PAVEMENT-EXISTING								
OVERLAY A	21120.0	SY	118970.65	ASPH CONC TOP C	T	13	34.50	0.05288
THICKNESS:	3.0	IN		TACK COAT	GAL	15	2.00	0.05
				CLEAN EXIST PAV	SY	103	0.06	1.00
SAW & SEAL AC OVERLAY	2640.0	LF	13200.00	SAW &SEAL JTS I	LF	11	5.00	1.00000
CLEAN JOINTS								
633.05 METHOD (LS FOR PROJECT)	3696.0	LS	3696.00					
DETERMINED BY PROJECT TYPE								
ENTER DOLLAR AM'T.								
DRAINAGE								
EDGE DRAINAGE (EACH SIDE)	10560.0	LF	61600.60	TRENCH/CULVERT	CY	8	17.00	0.16667
(6" UNDERDRAIN PIPE RUNS)				OPTIONAL UNDRDR	LF	27	3.00	1.00
PAVEMENT MARKINGS								
EPOXY- LINES (CONC PAVT ONLY)	11880.0	LF	3564.00	WHT EPOXY REFLE	LF	161	0.30	1.00000
SPECIALS								
SPECIALS								
SHOULDER BACKUP (15304.0117)	4102.0	LS	4102.00					
AC & PCC JT. REPAIR (18403.88)	55440.0	LS	55440.00					

TABLE 3 (cont.)

DATE: 08/22/91 TIME: 11:06:53 PAGE 2

PROJECT COST BREAKDOWN

PRINT OUT OF PRELIMINARY ESTIMATE FOR PIN NO. 1234.57
PROJECT DESCRIPTION: TWO COURSE OVERLAY

OPERATION	QUANTITY	COST
TOTAL COST OF ALL OPERATIONS		$ 271,133.25
SURVEY 2-3%		$ 0.00
MAINTENANCE OF TRAFFIC 5-10%	7.5 %	$ 20,334.99
SUBTOTAL		$ 291,468.24
MOBILIZATION	4.0 %	$ 11,658.73
SUBTOTAL		$ 303,126.97
CONTINGENCIES - PIR 25% I-20%, IV-15%, 75%-10%		$ 0.00
PRESENT CONSTRUCTION COST		$ 303,126.97

08/22/91

SUMMARY OF PROJECT COSTS

P.I.N. : 1234.57 PROGRAMMED AMOUNT: $ 400,000.00
PROJECT DESC. :TWO COURSE OVERLAY
PROJECT PHASE:

PRESENT COSTS

CURRENT ESTIMATED COST: $ 303,126.97

WORK NOT INCLUDED IN CURRENT CONSTRUCTION COST

RAILROAD FORCE ACCOUNT WORK:	$ 0.00
UTILITIES:	$ 0.00
AUTHORITY WORK:	$ 0.00
OTHER:	$ 0.00
OTHER:	$ 0.00
CONSTRUCTION COST (SUM OF THE ABOVE):	$ 303,126.97

PRELIMINARY ENGINEERING @ 8.00% OF CURRENT EST. COST: $ 24,250.16
CONSTRUCTION INSPECTION @ 12.00% OF CURRENT EST. COST: $ 36,375.24
RIGHT-OF-WAY ACQUISITION: $ 0.00

TOTAL CURRENT PROJECT COST: $ 363,752.37

TABLE 4: COSTS OF MULTIPLE-COURSE OVERLAY OPERATIONS

PRELIMINARY ESTIMATE PROGRAM

PREPARED BY:_____
DATE:_____
CHECKED BY:_____
DATE:_____

PROJECT IDENTIFICATION NUMBER: 1234.56
PROJECT ESTIMATE PHASE:
TYPE OF CONSTRUCTION: 1- R-P MULTIPLE COURSE OVERLAY

PRESENT COST
$ 347,113.64

PRINT OUT OF PRELIMINARY ESTIMATE FOR PIN NO. 1234.56
PROJECT DESCRIPTION MULTIPLE COURSE OVERLAY

DATE: 08/22/91
TIME: 11:04:13 PAGE 1

OPERATION	QUANTITY	UNIT	COST	BREAKDOWN	UNIT	REFNO.	PRICE	FACTOR
EARTHWORK								
EARTHWORK								
EXCAVATION - EARTH	1760.0	CY	10560.00	UNCL EXCAVATION	CY	1	6.00	1.00000
PAVEMENT EXISTING								
PAVEMENT-EXISTING								
OVERLAY A	21120.0	SY	118970.65	ASPH CONC TOP C	T	13	34.50	0.05288
THICKNESS:	3.0	IN		TACK COAT	GAL	15	2.00	0.05
				CLEAN EXIST PAV	SY	103	0.06	1.00
SAW & SEAL AC OVERLAY	2640.0	LF	13200.00	SAW &SEAL JTS I	LF	11	5.00	1.00000
CLEAN JOINTS								
633.05 METHOD (LS FOR PROJECT)	3696.0	LS	3696.00					
DETERMINED BY PROJECT TYPE								
ENTER DOLLAR AM'T.								
TRUEING & LEVELING	21120.0	SY	37972.07	ASPH CONC TOP C	T	13	34.00	0.05288
THICKNESS:	1.0	IN						
DRAINAGE								
EDGE DRAINAGE (EACH SIDE)	10560.0	LF	61600.60	TRENCH/CULVERT	CY	8	17.00	0.16667
(6" UNDERDRAIN PIPE RUNS)				OPTIONAL UNDRDR	LF	27	3.00	1.00
PAVEMENT MARKINGS								
EPOXY- LINES (CONC PAVT ONLY)	11880.0	LF	3564.00	WHT EPOXY REFLE	LF	161	0.30	1.00000
SPECIALS								
SPECIALS								
SHOULDER BACKUP (15304.0117)	5474.0	LS	5474.00					
AC & PCC JT. REPAIR (18403.88)	55440.0	LS	55440.00					

TABLE 4 (cont.)

DATE: 08/22/91 TIME: 11:04:19 PAGE 2

PROJECT COST BREAKDOWN

PRINT OUT OF PRELIMINARY ESTIMATE FOR PIN NO. 1234.56
PROJECT DESCRIPTION: MULTIPLE COURSE OVERLAY

OPERATION	QUANTITY	COST
TOTAL COST OF ALL OPERATIONS		$ 310,477.32
SURVEY 2-3%		$ 0.00
MAINTENANCE OF TRAFFIC 5-10%	7.5 %	$ 23,285.80
SUBTOTAL		$ 333,763.12
MOBILIZATION	4.0 %	$ 13,350.52
SUBTOTAL		$ 347,113.64
CONTINGENCIES - PIR 25% I-20%, IV-15%, 75%-10%		$ 0.00
PRESENT CONSTRUCTION COST		$ 347,113.64

08/22/91

SUMMARY OF PROJECT COSTS

P.I.N. : 1234.56 PROGRAMMED AMOUNT: $ 400,000.00
PROJECT DESC. :MULTIPLE COURSE OVERLAY
PROJECT PHASE:

PRESENT COSTS

CURRENT ESTIMATED COST: $ 347,113.64

WORK NOT INCLUDED IN CURRENT CONSTRUCTION COST

RAILROAD FORCE ACCOUNT WORK:	$ 0.00
UTILITIES:	$ 0.00
AUTHORITY WORK:	$ 0.00
OTHER:	$ 0.00
OTHER:	$ 0.00
CONSTRUCTION COST (SUM OF THE ABOVE):	$ 347,113.64

PRELIMINARY ENGINEERING @ 8.00% OF CURRENT EST. COST: $ 27,769.09
CONSTRUCTION INSPECTION @ 12.00% OF CURRENT EST. COST: $ 41,653.64
RIGHT-OF-WAY ACQUISITION: $ 0.00

TOTAL CURRENT PROJECT COST: $ 416,536.37

When this is the case, those items must be included in the appropriate alternative. For example, consider a LCC analysis comparing Full-Depth Segment Replacement of PCC pavement and 5" Asphalt Concrete Overlay Preceded By Cracking and Seating. In the latter alternative, it may be necessary to include raising the guiderail, curbs, and sidewalks. For the final estimate of a chosen alternative, all items/operations must be considered.

Future treatment costs are determined in the same manner as initial treatment cost. Again, the cost of each future treatment is estimated as a separate project. Pages C-4 through C-5 tabulate future treatment costs for the 3" AC Overlay. These costs were determined by calculating quantities based on types and amounts of distresses recorded in the Distress Data Forms. Note that several treatments applied at different times are identical. Only one calculation is required for each identical treatment. Pages C-6 through C-8 tabulate future treatment costs for the 4" AC Overlay.

Salvage values are determined by multiplying the ratio of unused to expected service life by cost of the treatment. For example, a 1-1/2" AC Course applied during year 27 of the two-course overlay treatment strategy has a salvage value: 5 years remaining life/8 year expected life x the cost of 1-1/2" of AC, or

$$5/8 \times \$324,688 = \$202,930.$$

As total costs for initial and future treatments are determined, they are placed in the Present Cost columns of tabulations similar to Tables 5 and 6. In these tables each treatment is briefly described, the year applied is noted, and also the Present Cost of each treatment. (Present Worth will be discussed next.) The sum of the Present Costs gives Total Present Cost for the treatment strategy. Salvage values are considered negative values when calculating Total Present Cost.

Compare Treatment Strategies Using The Present Worth Method

Present Worth of a treatment strategy may be thought of as the amount of money that would have to be invested now to fund future treatments when necessary. To account for the time-value of money, the Present Worth Method of LCC discounts future treatment costs to their worth in today's dollars. The rate at which future treatments are discounted, or "discount rate," is the difference between return on public investments (interest) and inflation. Returns on public investment result from improved infrastructure, employment, sales, income and sales taxes, and benefits to local economies. Relationships among these factors are complex. Studies show that over time the discount rate is about 4 percent. Department policy is to use a discount rate of 4 percent.

The Present Worth Method discounts future treatment costs to their worth in today's dollars by multiplying Present Cost of each treatment by a Present Worth Factor (PWF). A PWF is equal to $1/(1+i)^n$, where i is the discount rate and n is the year the treatment is applied. (P/F,i,n) is standard notation for the PWF. In Tables 5 and 6, PWFs are calculated for a discount rate of 4 percent. For example, PWF for a treatment applied in the 15th year is

$$(P/F,4\%,15) = 1/(1+.04)^{15} = 0.5553.$$

PWFs for each year a treatment is applied are found in the Present Worth Factor columns

of Tables 5 and 6. Present Worths of treatments are obtained by multiplying Present Cost of the treatment and the PWF for the year the treatment is applied. The two-course overlay applied in the 15th year in Table 6 has a Present Worth of

$$\$529,234 \times 0.5553 = \$293,884.$$

Present Worths are summed to obtain a Total Present Worth. Present Worths of salvage values are considered negative values when calculating Total Present Worth. PWF for all salvage values is determined for the last year in the analysis period. In this example,

$$(P/F,4\%,30) = 1/(1+.04)^{30} = 0.3083.$$

PWFs may be calculated or obtained from Table 7, where values are calculated for a 4-percent discount rate. The treatment strategy with the smallest Total Present Worth is the most cost-effective.

Perform A Sensitivity Analysis

This is performed to determine how sensitive a LCC analysis is to a particular variable. Treatment service lives, treatment timing, future treatment strategies, and item costs may be varied for a sensitivity analysis. A sensitivity analysis is basically a recalculation of LCCs with one changing variable. If one variable is changed and the subsequent LCC analysis shows that the same treatment strategy continues to be the most cost-effective, the LCC analysis is not sensitive to that variable. This means the decision is more likely to be correct. If changing one variable makes another treatment strategy more cost-effective, the LCC analysis is sensitive to that variable. More effort should be given to determining the exact value or nature of a variable if an LCC analysis is sensitive to it.

Select The Best Treatment Strategy

Use results of the LCC analysis and other factors to select a treatment strategy for design and construction.

TABLE 5: COSTS OF AREA I, TWO-COURSE OVERLAY TREATMENT STRATEGY

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
3" AC Overlay	0	$727,458	1.0000	$727,458
Fill Longitudinal Cracks/Joints	2	1,560	.9246	1,442
Fill Longitudinal Cracks/Joints	4	1,560	.8548	1,333
Fill Longitudinal Cracks/Joints	6	1,560	.7903	1,233
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	8	2,424	.7307	1,771
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	10	2,424	.6756	1,638
3" AC Overlay	12	529,234	.6246	330,560
Fill Longitudinal Cracks/Joints	14	1,560	.5775	901
Fill Longitudinal Cracks/Joints	16	1,560	.5339	833
Fill Longitudinal Cracks/Joints	18	1,560	.4936	770
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	20	2,424	.4564	1,106
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	22	2,424	.4220	1,023
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	24	2,424	.3901	946
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	26	2,424	.3607	874
1-1/2" AC Overlay	27	324,688	.3468	112,602
Fill Longitudinal Cracks/Joints	29	2,070	.3207	664
Subtotal		1,607,354		1,185,154
1-1/2" AC Overlay, Sawed & Sealed Jts. 5-Yr Salvage Value		-202,930	.3083	-62,563
Fill Longitudinal Cracks/Joints, 1-Yr Salvage Value		-1,035	.3083	-319
Total		$1,403,389		$1,122,272

TABLE 6: COSTS OF AREA I, MULTIPLE-COURSE OVERLAY TREATMENT STRATEGY

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
4" AC Overlay	0	$833,042	1.0000	$833,042
Fill Longitudinal Cracks/Joints	2	1,048	.9246	969
Fill Longitudinal Cracks/Joints	4	1,048	.8548	896
Fill Longitudinal Cracks/Joints	6	1,048	.7903	828
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	8	1,914	.7307	1,399
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	10	1,914	.6756	1,293
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	12	1,914	.6246	1,195
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	14	1,914	.5775	1,105
3" AC Overlay	15	529,234	.5553	293,884
Fill Longitudinal Cracks/Joints	17	1,560	.5134	801
Fill Longitudinal Cracks/Joints	19	1,560	.4746	740
Fill Longitudinal Cracks/Joints	21	1,560	.4388	685
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	23	2,424	.4057	983
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	25	2,424	.3751	909
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	27	2,424	.3468	841
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	29	2,424	.3207	777
	Subtotal	1,387,452		1,140,347
Fill Longitudinal Cracks/Joints, Fill Sawed & Sealed Joints 1-Yr Salvage Value		-1,212	.3083	-374
	Total	$1,386,240		$1,139,973

TABLE 7: PRESENT WORTH FACTORS (P/F,4%,n)

Year (n)	PWF	Year (n)	PWF
0	1.0000	26	0.3607
1	0.9615	27	0.3468
2	0.9246	28	0.3335
3	0.8890	29	0.3207
4	0.8548	30	0.3083
5	0.8219	31	0.2965
6	0.7903	32	0.2851
7	0.7599	33	0.2741
8	0.7307	34	0.2636
9	0.7026	35	0.2534
10	0.6756	36	0.2437
11	0.6496	37	0.2343
12	0.6246	38	0.2253
13	0.6006	39	0.2166
14	0.5775	40	0.2083
15	0.5553	41	0.2003
16	0.5339	42	0.1926
17	0.5134	43	0.1852
18	0.4936	44	0.1780
19	0.4746	45	0.1712
20	0.4564	46	0.1646
21	0.4388	47	0.1583
22	0.4220	48	0.1522
23	0.4057	49	0.1463
24	0.3901	50	0.1407
25	0.3751	51	0.1353

PART 4: MODEL PAVEMENT EVALUATION REPORT

PART 4: MODEL PAVEMENT EVALUATION REPORT

The following model pavement evaluation report was created to show three areas exhibiting considerable differences in pavement distress, design requirements, and/or design constraints. Its purpose is to show the reader a variety of situations that could be encountered in developing various treatment strategies. Generally, existing pavement distress is not as diverse as shown here. It is thus unlikely that actual reports will have to be as voluminous as this example.

This model report also contains background information concerning probable causes of distress. This is not required in pavement evaluation reports unless the author feels its inclusion is critical to those reviewing the rehabilitation analysis and treatment selection strategies. For the reader's convenience, the information considered to be background in the model report has been *italicized.*

The model report is included in this volume of the Manual as an example of format and methodology. Format and methodology, however, should not be confused with writing style nor should the reader feel it necessary to adopt the author's style. Rather, the reader is encouraged to use and develop his own style.

Pavement evaluation reports, however, should contain information under each of the following general headings;

1. Background
2. Data Collection And Reduction
3. Field Observations
4. Other Investigations (if applicable, this includes coring, discussion with others and information from them etc.)
5. Alternative Selection
6. Rehabilitation, Future Treatment, and Life-Cycle Costs (Time Lines and Cost Summaries)
7. Analysis Summary
8. Recommendations
9. Appendices
    - A. Project Information Form (BR-46)
    - B. Distress Data Forms (BR-47 and/or BR-48)
    - C. Alternative Cost Estimates: Area I
    - D. Alternative Cost Estimates: Area II
    - E. Alternative Cost Estimates: Area III

PAVEMENT EVALUATION REPORT

PIN 9040.90

ROUTE 66, SOMEWHERE TO NOWHERE

BUSH COUNTY

BACKGROUND

This project is a 7-mile two-lane facility originally constructed in 1963 under Contract FAC 62-10. From the southern end, the highway goes through a relatively flat wooded area with scattered residences for the first 2 miles. The next 3 miles pass through farmland comprised of rolling hills. The final 2 miles are within the Village of Nowhere.

The pavement is mesh-reinforced portland cement concrete slabs separated at 60-ft intervals by transverse contraction joints. Both the longitudinal and transverse joints were sawed and then sealed with preformed neoprene extrusions. Two-piece malleable-iron load-transfer devices were used as transverse joint supports. In the rural areas, 6-ft shoulders were provided. In the village 3-ft wide concrete gutters beyond the 6-ft shoulders direct runoff to a closed drainage system.

In 1985, the southernmost 2 miles were overlaid by state maintenance forces with a 1-in. AC armor coat to alleviate a rideability problem caused by a combination of transverse-joint faulting and D-crack-related joint spalling. Other maintenance efforts have included blowup and spall repair with AC patches, crack filling with hot-poured rubber asphalt, and wedging and surface treating of shoulders. For additional details see the Project Information Form (Appendix A).

In the rural areas, the existing pavement and shoulders are to be rehabilitated. In the village, parking lanes and curbs will be added, existing sidewalks replaced, and the existing closed drainage system will be modified and upgraded.

DATA COLLECTION AND REDUCTION

During the initial drive-through, it was determined that there was enough difference within the project limits to collect and evaluate pavement distress data in three separate areas. From south to north, these are:

Area I: The first 2 miles through wooded flatland.

Area II: 3 miles through farmland.

Area III: The final 2 miles within the Village of Nowhere.

The second drive-through located specific areas of isolated distress. These were recorded and appear under the first three headings of the Distress Data Forms (Appendix B).

After the second drive-through, detailed distress data were collected at 1/10-mile sections in each half-mile segment of the project. These data appear under the remaining headings of the Distress Data Forms (Appendix B). As can be seen, these data were totaled, and where appropriate expressed as percentages. This information, as well as that from isolated distress areas, was then analyzed and used to select and develop cost estimates for the rehabilitation alternatives presented later in this report.

The following describes existing distresses as observed in the three areas. Distress is discussed in the same order that it appears on the forms.

FIELD OBSERVATIONS IN AREA I

The asphalt concrete overlay, placed by state maintenance forces 6 years ago, exhibits multiple cracking and some material loss (potholes) over transverse joints of the underlying portland cement concrete pavement. *Most likely, single cracks appeared in the overlay during the winter following placement, the result of thermal contraction in underlying slabs. Additional crack development and material loss took place over time because of existing D-cracking in the underlying pavement, deicing chemical and water penetration, aggregate stripping, and the action of traffic.*

Multiple cracking is also present over the longitudinal joint of the underlying portland cement concrete pavement. *Probably, initial cracks developed because of the inherent weakness built into an overlay when asphalt concrete is placed lane-at-a-time (cold joints). Subsequent cracks developed for the same reasons previously stated.*

Minor wheelpath rutting was the only other pavement deficiency found in Area I, *the result of overlay consolidation from repetitive traffic loading.*

Shoulders in Area I exhibit multiple cracking and some potholing. Separation between the pavement and shoulder has allowed runoff to penetrate and wash away some fines, weakening subsurface gravel courses. This has caused some settlement (lane/shoulder dropoff), secondary cracking, and surface potholing. Traffic encroachment has aggravated this situation. However, no isolated areas of shoulder deformation were found.

FIELD OBSERVATIONS IN AREA II

Settlements were found at five locations, four over existing cross-culverts and one at a structure approach. *Most likely, they resulted from differential compaction that occurred during construction.*

Four full-width blowups and one partial-width blowup have also occurred in the area. *These are the result of transverse joint sealer failure and subsequent joint and crack infiltration of incompressible material.*

Maintenance forces have patched the settlements and blowups with asphalt concrete to restore the original profile and cross-slope and to improve rideability.

The preformed neoprene used to seal transverse and longitudinal joints exhibits compression set. Beneath the sealers, joints are filled with incompressible material. *Historically, extrusions of this vintage have failed after 2 to 3 years of service. Consequently, joints have been unsealed for sometime.*

Generally, transverse joint faulting in this area is between 3/8 and 3/4 in. *indicating that the two-piece malleable-iron load-transfer devices have experienced section loss from corrosion and wear. Joint-support-device degradation is triggered when joint seals fail, allowing ingress of corrosive deicing chemicals. Pavement rideability is considered objectionable if transverse joint faulting is 1/4 in. or more.*

Transverse joint separation has occurred at transverse joints near blowups. *When blowups occur, joints open as adjacent pavement slabs move toward the stress-relieved area. This provides additional space for incompressible accumulation, renewed stress buildup, and potential for future blowups.*

Almost all transverse and longitudinal joint distress (spalling) encountered can be attributed to D-cracking, *a condition associated with using a coarse aggregate sensitive to freeze-thaw damage. Joints are particularly vulnerable because additional faces are exposed that can absorb free moisture.* Spalls have been repaired with asphalt concrete patches by state maintenance forces.

Longitudinal joint separation has occurred between pavement lanes on both sides of the partial-width blowup found in Section 4. Subsequent migration of pavement slabs toward the blowup in the affected lane has sheared off longitudinal joint ties between lanes, as shown by misalignment of transverse joints. Free from the restraint of ties, accumulation of incompressible material within the joint is forcing the adjacent lanes apart.

There is a significant number of slab cracks within the area. *Slab cracks develop for many reasons. Those appearing early in service life of a pavement can usually be traced to a flaw in construction. Those developing later usually are caused by loss of subbase support. Regardless of their origin, cracks disrupt the normally predictable expansion and contraction characteristics of slabs and opening and closing of joints.* State maintenance forces have filled these cracks with asphalt, in an attempt to discourage infiltration.

Rut measurements in the wheelpaths indicate that loss of mortar and fine aggregate in the surface has been minimal. Consequently, disruption of cross-slope drainage is insignificant.

Non-joint spalling consists of surface popouts, *the result of D-cracking in the absorptive coarse aggregate within the concrete matrix.*

Shoulder deterioration is similar to that found in Area I, exhibiting multiple cracking throughout, with some potholing in Section 4. The separation between shoulder and pavement is allowing runoff penetration to subsurface courses and shoulders have subsided. Deformation has also occurred in Sections 3 and 5 near cross-culverts.

FIELD OBSERVATIONS IN AREA III

Within the village, settlements were found over underlying cross-culverts and at utility cuts made since the pavement was built. These were patched with asphalt concrete to restore the pavement's profile and rideability, but most exhibit distortion, rutting, and/or ravelling.

Four partial-width and four full-width blowups have also occurred, *the result of sealer failure and joint infiltration.* Those too were patched with asphalt concrete and are exhibiting distress similar to that found in the settlement patches. No paver-laid asphalt concrete overlay patches were found.

Many of the original preformed neoprene sealers have been lost from the joints, which are filled with incompressible material. The extrusions remaining have failed in compression set and are allowing infiltration of fines and water.

Transverse joint faulting is objectionable because of load-transfer device disengagement, corrosion, and wear.

Transverse joint separation has occurred adjoining blowups. Pavement migration at partial-width blowups has caused misalignment of transverse joints in affected areas.

Most existing transverse joint distress (spalling) can be attributed to D-cracking, *a consequence of using absorptive aggregate in the concrete.* Spalls have been patched with asphalt concrete, but new spalls have developed around the patches, reducing their effectiveness. Longitudinal joint distress (spalling) is also D-crack related.

Longitudinal joint separation has occurred between lanes in the immediate vicinity of partial-width blowups. Here, longitudinal joint ties have sheared because of slab migration. Joint infiltration is forcing the lanes apart.

Most pavement slabs in the area contain working cracks, *indicating abnormal slab expansion and contraction and unpredictable joint movement.* State maintenance forces have attempted to delay infiltration as remnants of asphalt filler were found in the cracks.

Although some surface mortar loss and large-aggregate polishing has occurred, measurements show minimal wheelpath rutting. Consequently, cross-slope drainage has not been seriously affected.

Most non-joint spalling recorded consists of surface popouts, *the result of freeze-thaw damage of the larger absorptive aggregate in the concrete.* The remainder resulted from corroding wire mesh placed too close to the surface when the pavement was constructed.

Shoulder condition in this area is similar to that found in Areas I and II. Runoff is penetrating to subsurface layers through the separation between the pavement and shoulder, causing multiple cracking and dropoff. Vehicular encroachment is aggravating the situation. However, no shoulder deformation was found.

OTHER INVESTIGATIONS

Following the pavement evaluation, the Bush County Resident Engineer was contacted to determine what level of maintenance is needed on the existing facility and to learn of any particular problems he may have experienced that were not evident during the field evaluation. This indicated the following:

1. Efforts to maintain the highway have progressively increased in recent years. Despite this effort, pavement and shoulder condition continues to decline.

2. Continuous effort is now required to patch new spalls that are developing as a result of D-cracking and to replace older patches that have failed.

3. Annual crack sealing and shoulder repair is needed but cannot be done with the limited resources available.

4. Minor frost heaves have occurred in shoulders in Areas II and III.

The Regional Soils Engineer has inspected the road and recommends that the existing shoulders in Areas I and II be removed and replaced. He also suggests that underdrain be installed in all three areas to ensure positive drainage and reduce frost heave susceptibility.

Pavement cores were taken in Area I to determine the extent of D-crack-related distress beneath the existing overlay. As the field observations had indicated, structural damage was confined to PCC in the immediate vicinity of underlying joints. Consequently, this deficiency should be addressed during development of a rehabilitation strategy.

Subsequent tests of the AC from cores showed satisfactory mix properties. The existing overlay thus could be recycled or left in place and used as a base for an overlay.

ALTERNATIVE SELECTION

AREA I

Multiple reflection cracking over underlying D-cracked joints is the only distress form of any consequence that has developed in the existing overlay since it was placed 6 years ago. It thus appears that for the most part structural integrity of the underlying portland cement concrete and subbase courses are adequate. There is, some doubt however, of structural adequacy in the immediate vicinity of underlying joints that have deteriorated from the effects of D-cracking. It is thus apparent that the rehabilitation strategy selected must include corrective measures to forestall the effects of D-cracking in the underlying concrete.

Given these conditions, it is apparent that some of the rehabilitation strategies available are not appropriate and can be eliminated from the selection process:

1. Do Nothing. Since the level of service continues to decline despite increasing maintenance efforts, this option is unacceptable.

2. Single-Course Overlay (1-1/2"). Expected service life of this rehabilitation strategy (8 years) is significantly less than desired.

3. Hot or Cold Recycling or Cold Milling and Replacement. Except for areas in the immediate vicinity of underlying PCC joints, the existing overlay is in good condition. Damaged areas can be removed and repaired and the remainder of the overlay left in place to be used as a base for a new overlay. These strategies thus are not appropriate.

4. Remove Flexible Overlay, Crack and Seat With Multiple-Course Overlay (5"). This technique is used when normal (thermally induced) expansion and contraction of pavement slabs is interrupted by slab cracks, rendering transverse joint movement unpredictable. In this pavement, the distress survey revealed that reflection cracks appear only over underlying transverse joints, indicating that normal movement is still occurring. The crack-and-seat strategy thus is not appropriate.

5. Remove Flexible Overlay, Rubblize With Multiple-Course Overlay (6"). This strategy is used in situations suitable for cracking and seating, but presence of underground utilities precludes use of the crack-and-seat method. Rubblizing thus is not appropriate for the given condition.

6. Reconstruct. Despite existing distress, structural capacity of the pavement is still adequate, capable of providing satisfactory service for years to come. This remaining service life would be lost if the pavement were reconstructed. Consequently, this rehabilitation strategy would not now be cost-effective.

Two rehabilitation strategies are appropriate (provided reflective cracking in the overlay and D-cracking at underlying joints are addressed):

1. Two-Course Overlay (3"). For this strategy to succeed, areas affected by reflective cracking and D-cracking have to be removed and replaced with AC patches. This can be accomplished with Item 18403.88 (Repair Defective AC Overlay And PCC At Underlying PCC Joints). Patches will improve structural integrity of the affected areas and provide a uniform base for the new resurfacing. Sawing and sealing over underlying joints will control thermally induced reflective cracks occurring in the new overlay. Continued D-cracking in the underlying PCC however, could shorten the expected service life of this alternative.

2. Multiple-Course Overlay (4"). Again, Item 18403.88 must be used to ensure the success of this strategy, which is more expensive. However, the additional thickness will add strength to the section and help delay the effects of D-cracking deterioration that will continue in the underlying PCC. Consequently, the predicted service life of this alternative is expected to be somewhat longer than the two-course overlay.

AREA II

Transverse joint faulting *the result of load-transfer-device failure* and transverse joint spalling *the result of D-cracking* are the primary distresses responsible for objectionable rideability of this pavement. Slab cracking is most likely the result of loss of subbase support beneath transverse joints and subsequent pavement deflection from traffic loading. Generally, however, the pavement and its foundation still appear to possess sufficient strength to be used as a base.

Given these conditions, the following available rehabilitation strategies are not appropriate and can be eliminated from the selection process:

1. Do Nothing. The magnitude of existing distress is such that state maintenance forces can no longer maintain an acceptable level of service. This alternative thus is not appropriate.

2. Concrete Pavement Restoration (CPR). This technique is appropriate for portland cement concrete pavements exhibiting low levels of distress. CPR techniques include joint resealing, fault grinding, permanent patching and segment replacement. Since distress levels are relatively high, CPR would not be cost-effective.

3. Sawed and Sealed Asphalt Concrete Overlay (3"). This strategy is used when movement from thermal expansion and contraction is still occurring in most PCC transverse joints. Sawing and sealing transverse joints in an asphalt overlay directly over underlying PCC joints confines reflective cracks to the sawcuts, minimizing secondary cracking and preventing intrusion of water and debris into the pavement structure. Slab cracks disrupt this scenario. Cracked slabs thus should be removed

and replaced in conjunction with this strategy; the more slab replacements required, the less attractive this alternative becomes. In this area, most slabs are cracked, and this strategy thus would not be cost-effective.

4. Sawed and Sealed Asphalt Concrete Overlay (4"). Warrants for this rehabilitation strategy are the same as for the previous one, the only difference being that the thicker overlay provides greater structural strength to the pavement section. Consequently, this alternative is not appropriate, as slab cracking is extensive.

5. Asphalt Concrete Overlay (6") Preceded By Rubblizing. Warrants for this strategy currently limit its use to severely distressed PCC pavement in urban settings where presence of underground utilities precludes use of the crack-and-seat option, and/or where pavement is to be widened. Since this area falls outside these parameters, this strategy is not appropriate.

The following rehabilitation strategies are appropriate:

1. Asphalt Concrete Overlay (5") Preceded By Cracking and Seating. This is appropriate when normal, thermally induced expansion and contraction of pavement slabs is interrupted by slab cracks, rendering transverse joint movement unpredictable. In this area, however, other distresses have to be addressed for this alternative to be effective. These include D-crack related joint spalling and transverse joint faulting. The former can be corrected using Item 18502.4466 (Repair Of Spalled Areas, Joints And/Or Cracks In Portland Cement Concrete Pavement). The latter can be corrected by wedging faults with asphalt concrete patches before overlay placement. Both will help provide a stable, uniform base on which to place and compact the new overlay courses. The 5-in. overlay will strengthen the highway section and forestall the effects of D-cracking in the underlying PCC pavement.

2. Reconstruct. Based on the amount and severity of distress in this area, this is another option worth consideration. With routine maintenance, a new full-depth asphalt concrete pavement could provide adequate service for 15 years before further rehabilitation would be required. Thirty years of service could be attained from a new portland cement concrete pavement before further rehabilitation would be necessary, provided isolated slab distresses are repaired and periodic maintenance is performed during that period.

AREA III

Rideability of the pavement within the village is objectionable because of faulting and spalling at transverse joints and cracks. *As previously stated, these deficiencies result from load-transfer-device failure and D-cracking.* Noted distress also disrupts the pavement's drainage characteristics, impeding efficiency of the existing drainage system. As is, the pavement is no longer serviceable. However, it and its supporting foundation are still suitable for use as a base.

Given these conditions, some rehabilitation strategies available obviously are not appropriate and can be eliminated:

1. Do Nothing. With limited resources at their disposal, state maintenance

forces have been unable to maintain a satisfactory level of service within the village. Consequently, this alternative is unacceptable.

2. Concrete Pavement Restoration (CPR). This alternative is appropriate for portland cement concrete pavements exhibiting low distress levels. Existing levels are such that this strategy would not be cost-effective.

3. Sawed-and-Sealed Asphalt Concrete Overlay (3"). Many slabs in this area contain cracks that have disrupted normal thermally induced movement occurring at transverse joints. Sawing and sealing over existing joints thus would be ineffective. Based on existing distress levels, it is also apparent that the pavement is structurally inadequate and should be restored. This cannot be achieved with 3 in. of AC. Consequently, this strategy is not appropriate.
4. Sawed and Sealed Asphalt Concrete Overlay (4"). This alternative would improve structural strength of the existing pavement section, but does not address unpredictability of thermal movement associated with slab cracking. It thus is not appropriate.

5. Asphalt Concrete Overlay (5") Preceded By Cracking and Seating. This rehabilitation strategy is appropriate given the amount and severity of existing distress, but presence of underground utilities near the pavement preclude its use.

The following rehabilitation strategies are appropriate;

1. Asphalt Concrete Overlay (6") Preceded By Rubblizing. This is particularly useful when utilities are located under a severely distressed portland cement concrete pavement. Rubblizing fragments the pavement in place without damaging utilities. It is also useful when pavement is to be widened. Here the rubblized pavement is supplemented with crushed stone and both materials are compacted with a vibratory roller for use as a base for a new pavement. Consequently, this alternative is ideally suited for the given conditions.

2. Reconstruct. Condition of the existing pavement is such that this is worth consideration. It is also compatible with plans to add parking lanes within the village. Further, the existing pavement can be removed and replaced without damaging underground utilities. Provided periodic maintenance, a new full-depth AC pavement could provide 15 years of service before further rehabilitation would be needed. With isolated slab distress repair and routine maintenance, 30 years of service could be expected from a new PCC pavement before further rehabilitation.

REHABILITATION, FUTURE TREATMENT, AND LIFE-CYCLE COSTS

REHABILITATION COSTS

Since cost is an important consideration in the rehabilitation selection process, cost estimates for each of the selected alternatives were prepared and are presented in Appendices C (Area I), D (Area II), and E (Area III). Quantities included in the computations are for a roadway section consisting of two 12-ft wide travel lanes and either two 6-ft wide shoulders or two 8-ft wide parking lanes. Estimates do not include items beyond these limits nor items for drainage adjustments/improvements within those limits (except for edge drains). Inclusion of these items will of course increase costs of the alternatives, but they do not

influence selection because these items are common to all the alternatives.

FUTURE TREATMENT COSTS

Cost estimates for the predicted maintenance needs of each of the selected alternatives also appear in Appendices C, D, and E, following the alternative cost estimates.

LIFE-CYCLE COSTS

Following are life-cycle time lines which combine initial rehabilitation and predicted future treatment costs for each of the selected alternatives in each area.

ANALYSIS SUMMARY

AREA I

As would be expected, the cost analysis shows that initial cost of rehabilitating Area I with a 3-in. AC overlay is less than with a 4-in. AC overlay. Even when future maintenance needs over the 30-year life cycle period are considered, the thinner overlay still appears to enjoy an economic advantage, as its present worth cost is less than its thicker counterpart.

AREAS II AND III

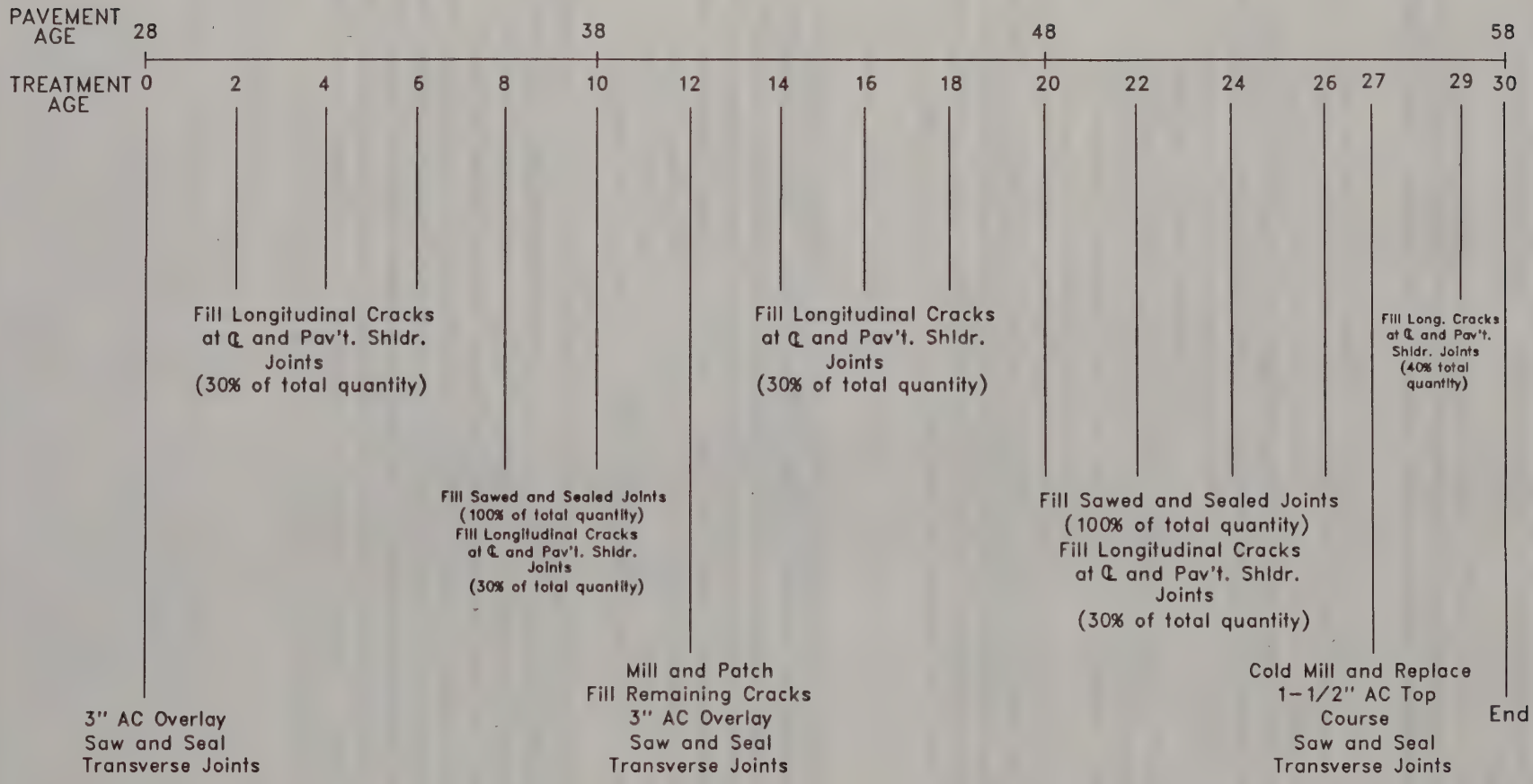
The cost analysis reveals that the crack-and-seat and rubblize alternatives are initially cheaper than the reconstruction alternatives. Further, maintenance needs of these alternatives over the 45-year life-cycle-analysis period are comparable to those of the reconstruction alternatives. These alternatives also conserve natural resources in that they use materials already in place rather than removing them to disposal areas.

RECOMMENDATIONS

Based on the findings of this pavement evaluation and analysis, it is recommended that Area I be rehabilitated with a 3-in. sawed-and-sealed AC overlay. Rehabilitation of Area II should be accomplished by cracking and seating the existing PCC pavement before resurfacing it with a 5-in. thick AC overlay. In Area III, it is recommended that the existing PCC pavement be rubblized before being overlaid with 6-in. of AC resurfacing. For these selected alternatives to achieve their desired service lives, it is further recommended that anticipated maintenance needs described in the life-cycle-cost analysis for each alternative be scheduled as shown, unless otherwise adjusted as a result of future observations and/or performance.

TWO–COURSE OVERLAY, 3" AC

AREA I



SALVAGE VALUE

1–1/2" AC Overlay – 5 Years
Saw and Seal Joints – 5 Years
Fill Cracks and Joints – 1 Year

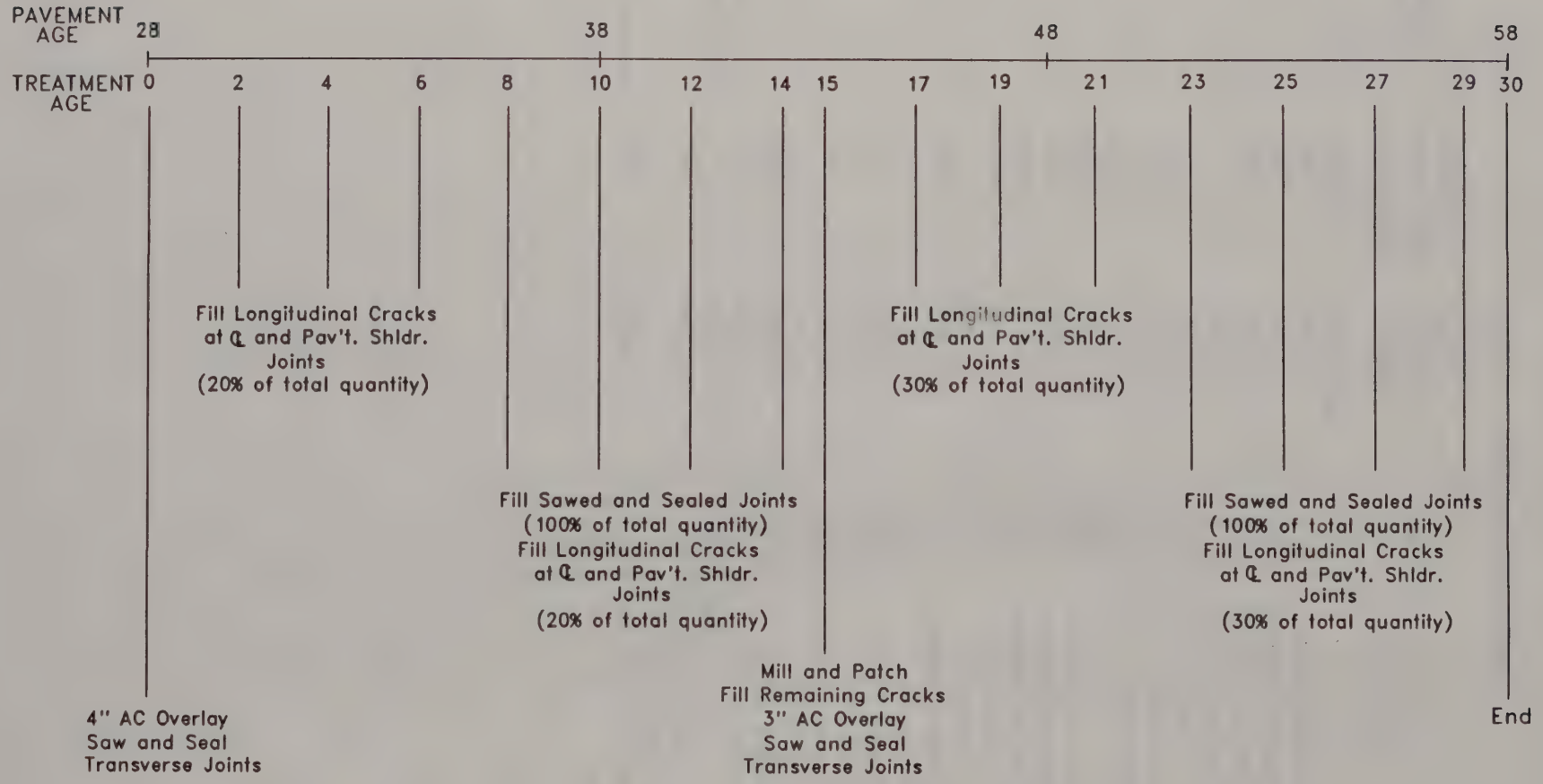
AREA I

TWO-COURSE OVERLAY, 3" AC

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
3" AC Overlay	0	$727,458	1.0000	$727,458
Fill Longitudinal Cracks/Joints	2	1,560	.9246	1,442
Fill Longitudinal Cracks/Joints	4	1,560	.8548	1,333
Fill Longitudinal Cracks/Joints	6	1,560	.7903	1,233
Fill Longitudinal Cracks/Joints	8	2,424	.7307	1,771
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	10	2,424	.6756	1,638
Fill Sawed & Sealed Joints				
3" AC Overlay	12	529,234	.6246	330,560
Fill Longitudinal Cracks/Joints	14	1,560	.5775	901
Fill Longitudinal Cracks/Joints	16	1,560	.5339	833
Fill Longitudinal Cracks/Joints	18	1,560	.4936	770
Fill Longitudinal Cracks/Joints	20	2,424	.4564	1,106
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	22	2,424	.4220	1,023
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	24	2,424	.3901	946
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	26	2,424	.3607	874
Fill Sawed & Sealed Joints				
1-1/2 Inch AC Overlay	27	324,688	.3468	112,602
Fill Longitudinal Cracks/Joints	29	2,070	.3207	664
Sub-Total		1,607,354		1,185,154
1-1/2" AC Overlay, Sawed & Sealed Jts.		-202,930	.3083	-62,563
5 Yrs. Salvage Value				
Fill Longitudinal Cracks/Joints,		-1,035	.3083	-319
1 Yr. Salvage Value				
Total		$1,403,389		$1,122,272

MUTIPLE–COURSE OVERLAY, 4" AC

AREA I



SALVAGE VALUE

Fill Cracks and Joints – 1 Year

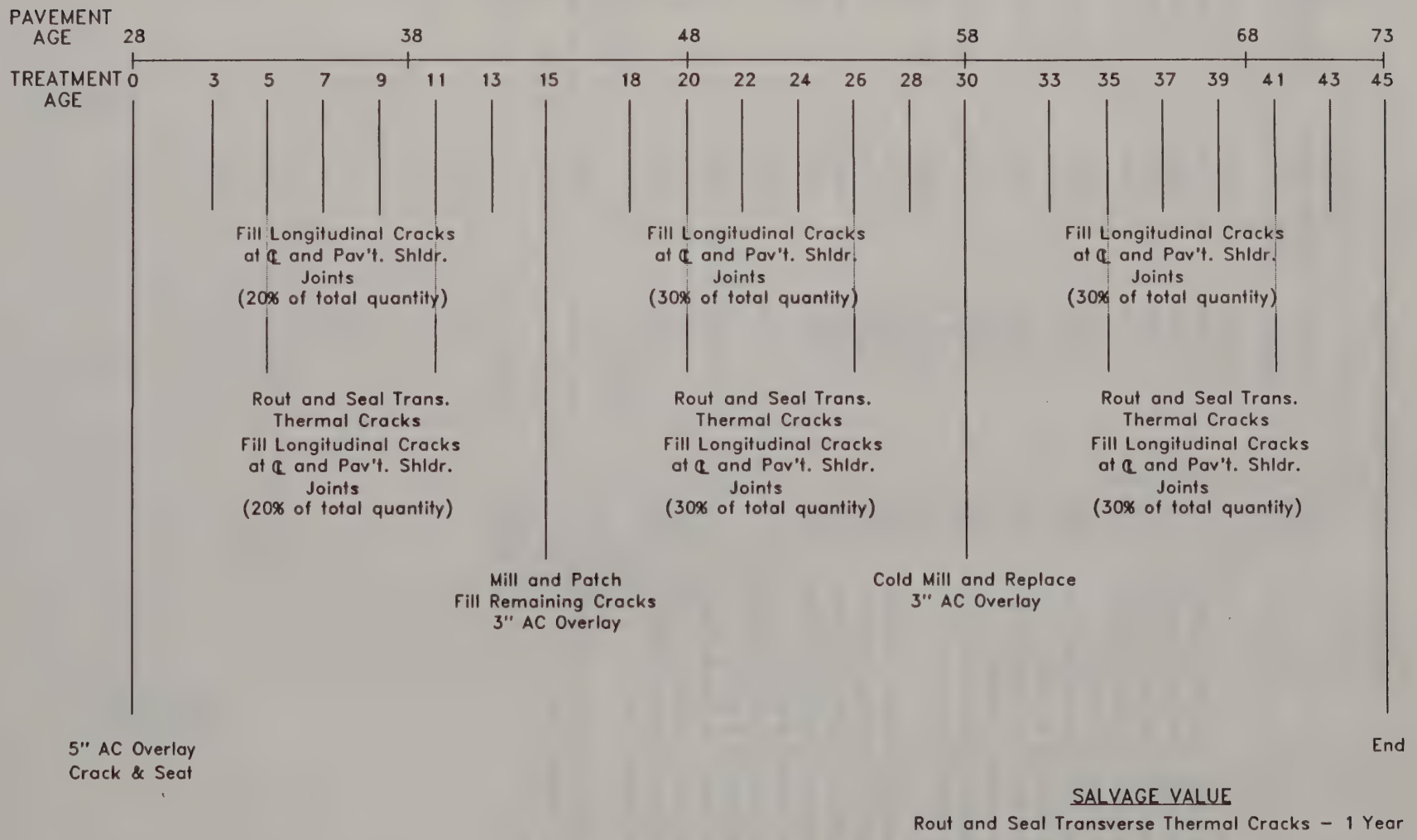
AREA I

MULTIPLE COURSE OVERLAY, 4" AC

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
4" AC Overlay	0	$833,042	1.0000	$833,042
Fill Longitudinal Cracks/Joints	2	1,048	.9246	969
Fill Longitudinal Cracks/Joints	4	1,048	.8548	896
Fill Longitudinal Cracks/Joints	6	1,048	.7903	828
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	8	1,914	.7307	1,399
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	10	1,914	.6756	1,293
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	12	1,914	.6246	1,195
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	14	1,914	.5775	1,105
3" AC Overlay	15	529,234	.5553	293,884
Fill Longitudinal Cracks/Joints	17	1,560	.5134	801
Fill Longitudinal Cracks/Joints	19	1,560	.4746	740
Fill Longitudinal Cracks/Joints	21	1,560	.4388	685
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	23	2,424	.4057	983
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	25	2,424	.3751	909
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	27	2,424	.3468	841
Fill Longitudinal Cracks/Joints Fill Sawed & Sealed Joints	29	2,424	.3207	777
Sub-Total		1,387,452		1,140,347
Fill Longitudinal Cracks/Joints, Fill Sawed & Sealed Joints 1 Yr. Salvage Value		-1,212	.3083	-374
Total		$1,386,240		$1,139,973

5" AC OVERLAY PRECEDED BY CRACK & SEAT

AREA II



SALVAGE VALUE

Rout and Seal Transverse Thermal Cracks – 1 Year

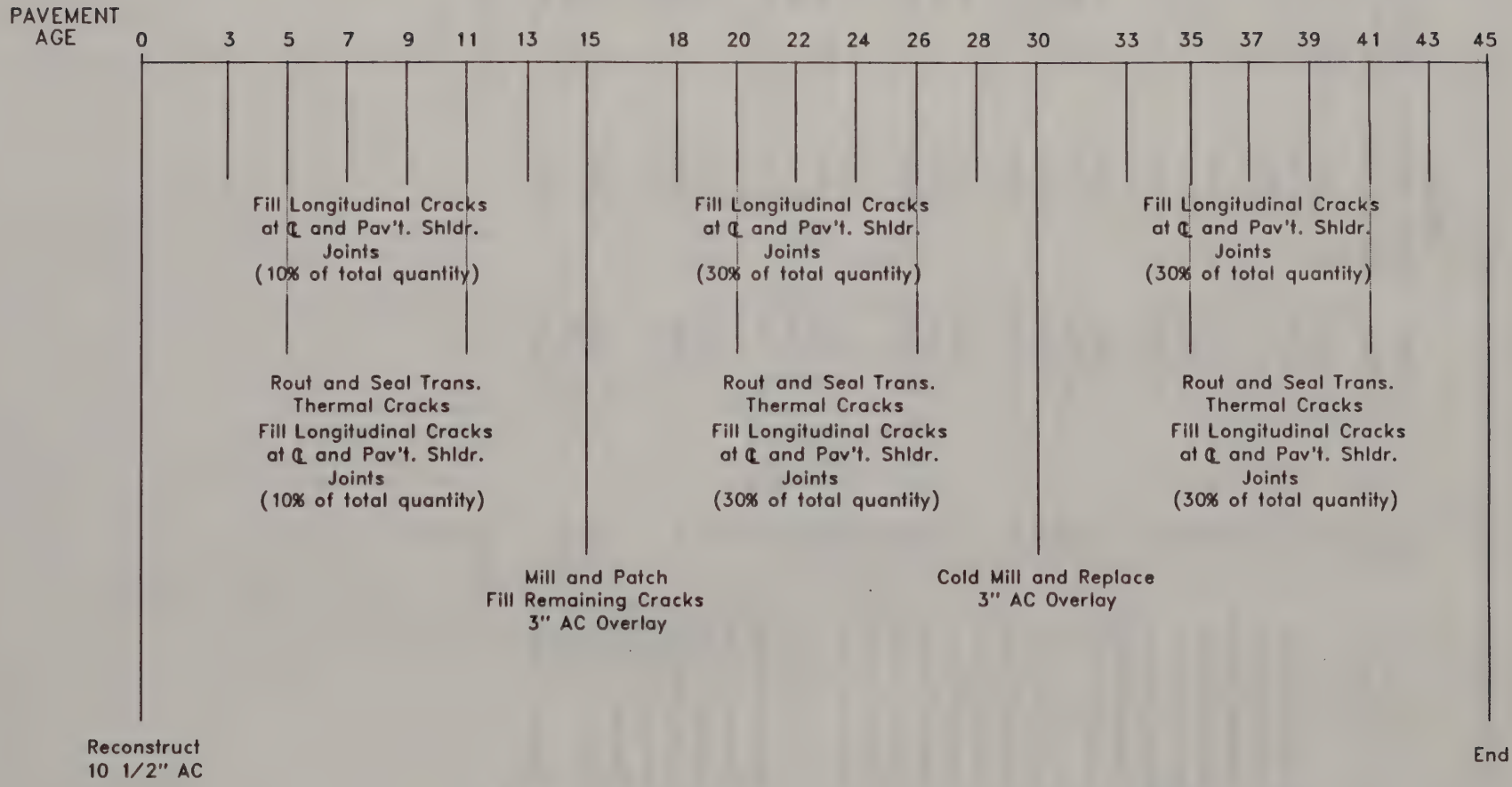
AREA II

5" AC OVERLAY PRECEDED BY CRACK & SEAT

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
5" AC Overlay	0	$1,279,395	1.0000	$1,279,395
Fill Longitudinal Cracks/Joints	3	1,572	.8890	1,398
Fill Longitudinal Cracks/Joints	5	18,012	.8219	14,804
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	7	1,572	.7599	1,195
Fill Longitudinal Cracks/Joints	9	1,572	.7026	1,104
Fill Longitudinal Cracks/Joints	11	18,012	.6496	11,701
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	13	1,572	.6006	944
3" AC Overlay	15	594,018	.5553	329,858
Fill Longitudinal Cracks/Joints	18	2,340	.4936	1,155
Fill Longitudinal Cracks/Joints	20	18,780	.4564	8,571
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	22	2,340	.4220	987
Fill Longitudinal Cracks/Joints	24	2,340	.3901	913
Fill Longitudinal Cracks/Joints	26	18,780	.3607	6,774
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	28	2,340	.3335	780
3" AC Overlay	30	748,122	.3083	230,646
Fill Longitudinal Cracks/Joints	33	2,340	.2741	641
Fill Longitudinal Cracks/Joints	35	18,780	.2534	4,759
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	37	2,340	.2343	548
Fill Longitudinal Cracks/Joints	39	2,340	.2166	507
Fill Longitudinal Cracks/Joints	41	18,780	.2003	3,762
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	43	2,340	.1852	433
Sub-Total		2,757,687		1,900,875
Rout & Seal Trans. Thermal Cracks		-3,288	.1712	-563
1 Yr. Salvage Value				
Total		$2,754,399		$1,900,312

RECONSTRUCT WITH 10–1/2" AC

AREA II



SALVAGE VALUE

Rout and Seal Transverse Thermal Cracks – 1 Year

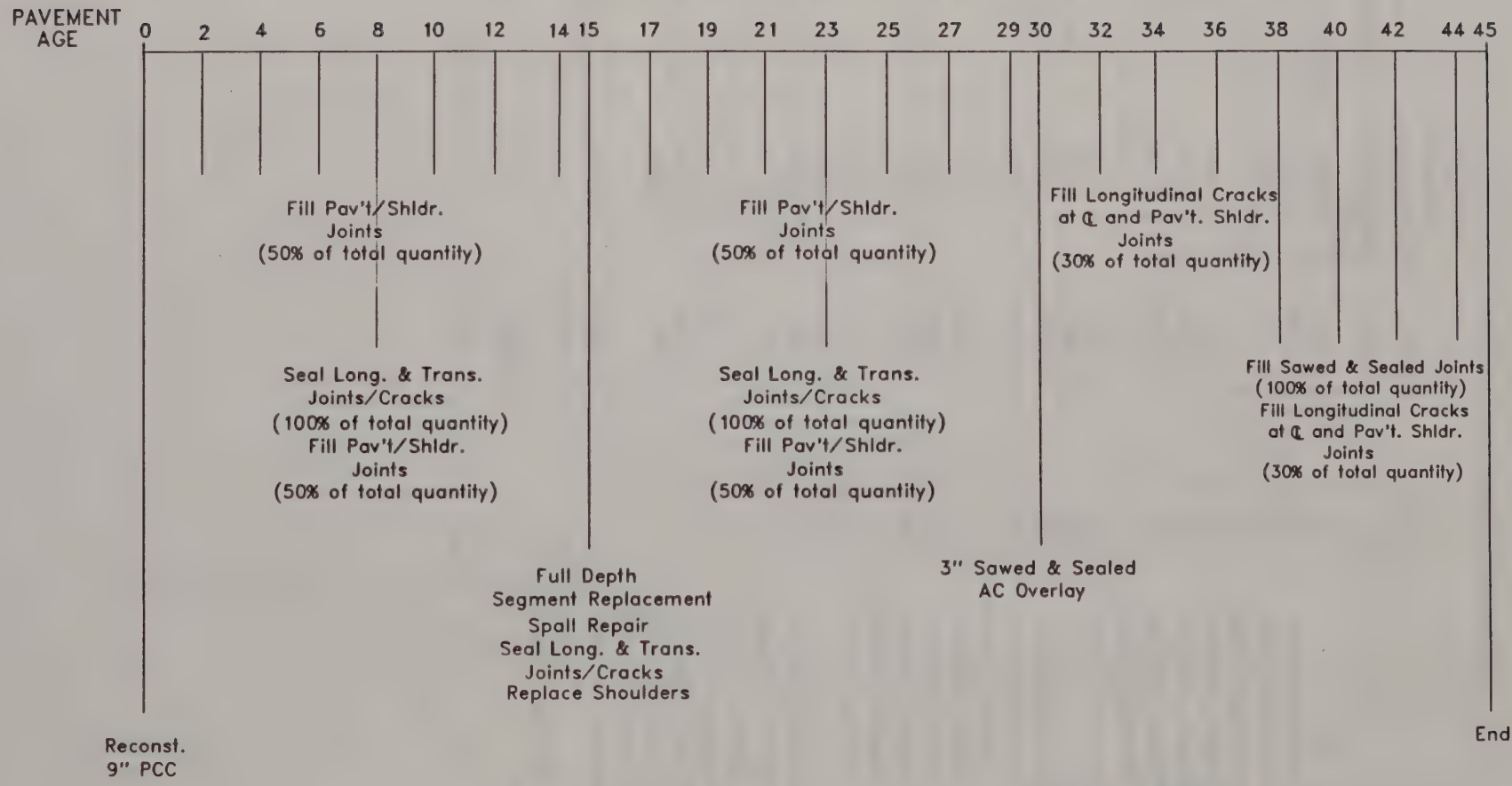
AREA II

RECONSTRUCT WITH 10-1/2" AC

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
Reconstruct 10-1/2" AC	0	$2,214,270	1.0000	$2,214,270
Fill Longitudinal Cracks/Joints	3	786	.8890	699
Fill Longitudinal Cracks/Joints	5	17,226	.8219	14,158
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	7	786	.7599	597
Fill Longitudinal Cracks/Joints	9	786	.7026	552
Fill Longitudinal Cracks/Joints	11	17,226	.6496	11,190
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	13	786	.6006	472
3" AC Overlay	15	594,021	.5553	329,860
Fill Longitudinal Cracks/Joints	18	2,340	.4936	1,155
Fill Longitudinal Cracks/Joints	20	18,780	.4564	8,571
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	22	2,340	.4220	987
Fill Longitudinal Cracks/Joints	24	2,340	.3901	913
Fill Longitudinal Cracks/Joints	26	18,780	.3607	6,774
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	28	2,340	.3335	780
3" AC Overlay	30	748,122	.3083	230,646
Fill Longitudinal Cracks/Joints	33	2,340	.2741	641
Fill Longitudinal Cracks/Joints	35	18,780	.2534	4,759
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	37	2,340	.2343	548
Fill Longitudinal Cracks/Joints	39	2,340	.2166	507
Fill Longitudinal Cracks/Joints	41	18,780	.2003	3,762
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	43	2,340	.1852	433
Sub-Total		3,687,849		2,832,274
Rout & Seal Trans. Thermal Cracks				
1 Yr. Salvage Value		-3,288	.1712	-563
Total		$3,684,561		$2,831,711

RECONSTRUCT WITH 9" PCC

AREA II



SALVAGE VALUE

Fill Sawed and Sealed Joints and Longitudinal Cracks at ℄ and Pav't. Shldr. Joints — 1 Year

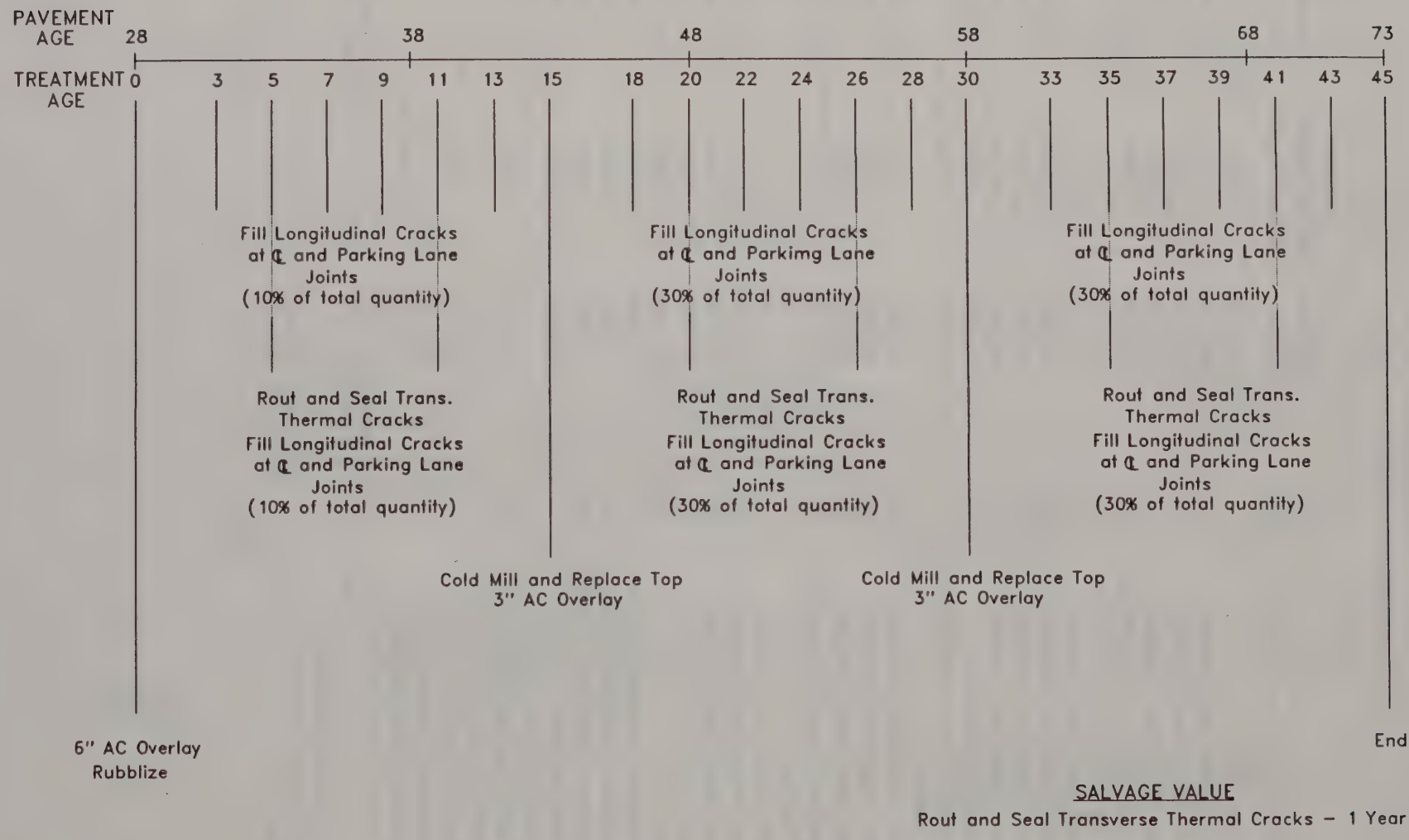
AREA II

RECONSTRUCT WITH 9" PCC

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
Reconstruct 9" PCC	0	$2,841,444	1.0000	$2,841,444
Fill Pavement Shoulder Joints	2	6,228	.9246	5,758
Fill Pavement Shoulder Joints	4	6,228	.8548	5,324
Fill Pavement Shoulder Joints	6	6,228	.7903	4,922
Seal Longitudinal and Transverse Joints and Cracks Fill Pavement Shoulder Joints	8	143,220	.7307	104,651
Fill Pavement Shoulder Joints	10	6,228	.6756	4,208
Fill Pavement Shoulder Joints	12	6.228	.6246	3,890
Fill Pavement Shoulder Joints	14	6,228	.5775	3,597
Repair Pavement/Shoulders	15	427,680	.5553	237,491
Seal Longitudinal and Transverse Joints and Cracks Fill Pavement Shoulder Joints	17	6,228	.5134	3,197
Fill Pavement Shoulder Joints	19	6,228	.4746	2,956
Fill Pavement Shoulder Joints	21	6,228	.4388	2,733
Seal Longitudinal and Transverse Joints and Cracks Fill Pavement Shoulder Joints	23	143,220	.4057	58,104
Fill Pavement Shoulder Joints	25	6,228	.3751	2,336
Fill Pavement Shoulder Joints	27	6,228	.3468	2,160
Fill Pavement Shoulder Joints	29	6,228	.3207	1,997
3" AC Overlay	30	870,507	.3083	268,377
Fill Longitudinal Cracks/Joints	32	2,340	.2851	667
Fill Longitudinal Cracks/Joints	34	2,340	.2636	617
Fill Longitudinal Cracks/Joints	36	2,340	.2437	570
Fill Sawed and Sealed Joints Fill Longitudinal Cracks/Joints	38	6,231	.2253	1,404
Fill Sawed and Sealed Joints Fill Longitudinal Cracks/Joints	40	6,231	.2083	1,298
Fill Sawed and Sealed Joints Fill Longitudinal Cracks/Joints	42	6,231	.1926	1,200
Fill Sawed and Sealed Joints Fill Longitudinal Cracks/Joints	44	6,231	.1780	1,109
Sub-Total		4,532,751		3,560,010
Fill Sawed & Sealed Joints Longitudinal Cracks/Joints - 1 Yr. Salvage Value		-3,116	.1712	-533
Total		$4,529,635		$3,559,477

6" AC OVERLAY PRECEDED BY RUBBLIZING

AREA III



SALVAGE VALUE

Rout and Seal Transverse Thermal Cracks – 1 Year

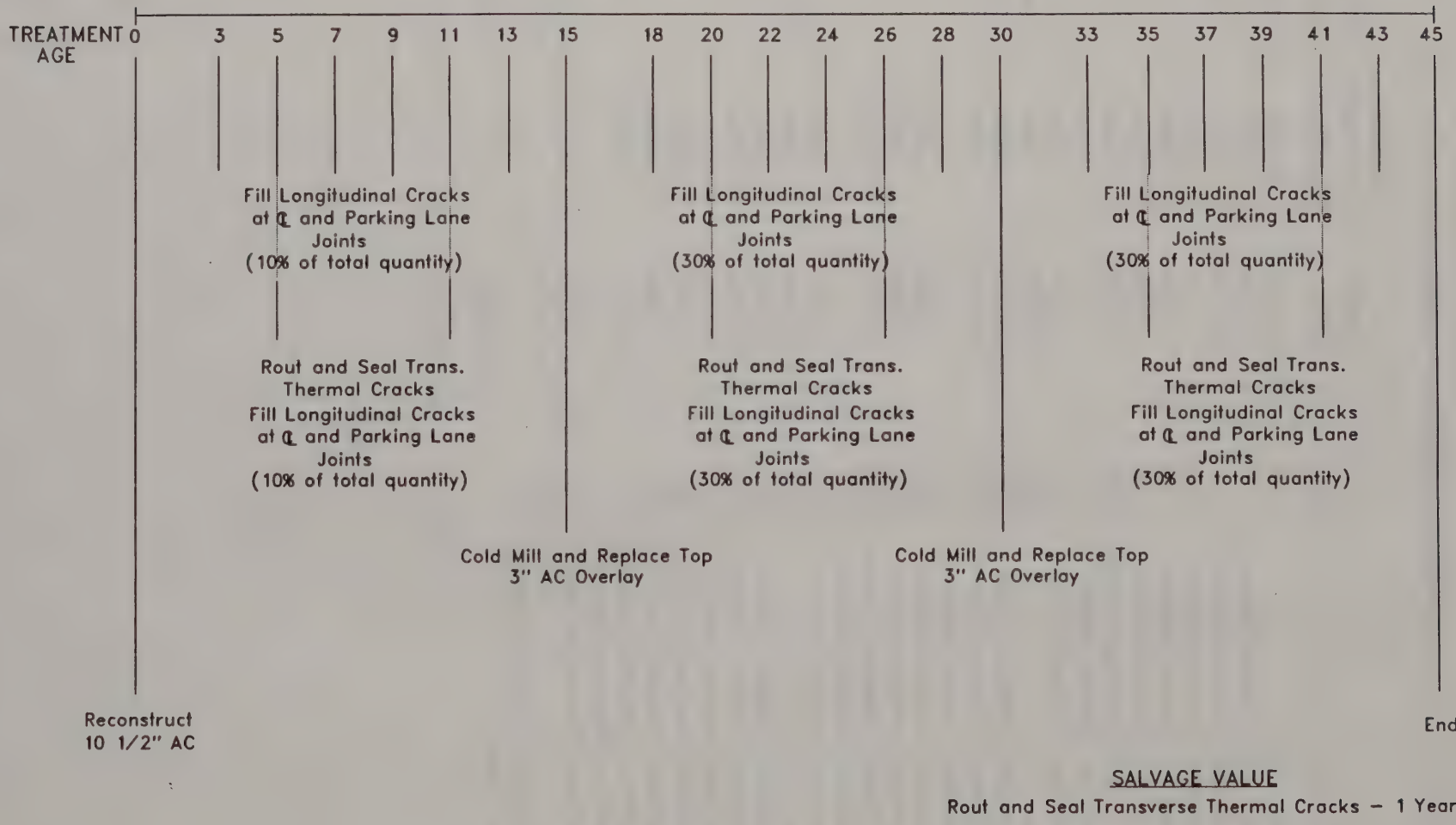
AREA III

6" AC OVERLAY PRECEDED BY RUBBLIZING

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
6" AC Overlay	0	$1,276,460	1.0000	$1,276,460
Fill Longitudinal Cracks/Joints	3	524	.8890	466
Rout & Seal Trans. Thermal Cracks	5	12,700	.8219	10,438
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	7	524	.7599	398
Fill Longitudinal Cracks/Joints	9	524	.7026	368
Rout & Seal Trans. Thermal Cracks	11	12,700	.6496	8,250
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	13	524	.6006	315
3" AC Overlay	15	557,618	.5553	309,645
Fill Longitudinal Cracks/Joints	18	1,560	.4936	770
Rout & Seal Trans. Thermal Cracks	20	13,736	.4564	6,269
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	22	1,560	.4220	658
Fill Longitudinal Cracks/Joints	24	1,560	.3901	609
Rout & Seal Trans. Thermal Cracks	26	13,736	.3607	4,955
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	28	1,560	.3335	520
3" AC Overlay	30	557,618	.3083	171,914
Fill Longitudinal Cracks/Joints	33	1,560	.2741	428
Rout & Seal Trans. Thermal Cracks	35	13,736	.2534	3,481
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	37	1,560	.2343	366
Fill Longitudinal Cracks/Joints	39	1,560	.2166	338
Rout & Seal Trans. Thermal Cracks	41	13,736	.2003	2,751
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	43	1,560	.1852	289
Sub-Total		2,486,616		1,799,688
Rout & Seal Trans. Thermal Cracks 1 Yr. Salvage Value		-2,435	.1712	-417
Total		$2,484,181		$1,799,271

RECONSTRUCT WITH 10–1/2" AC

AREA III



SALVAGE VALUE

Rout and Seal Transverse Thermal Cracks – 1 Year

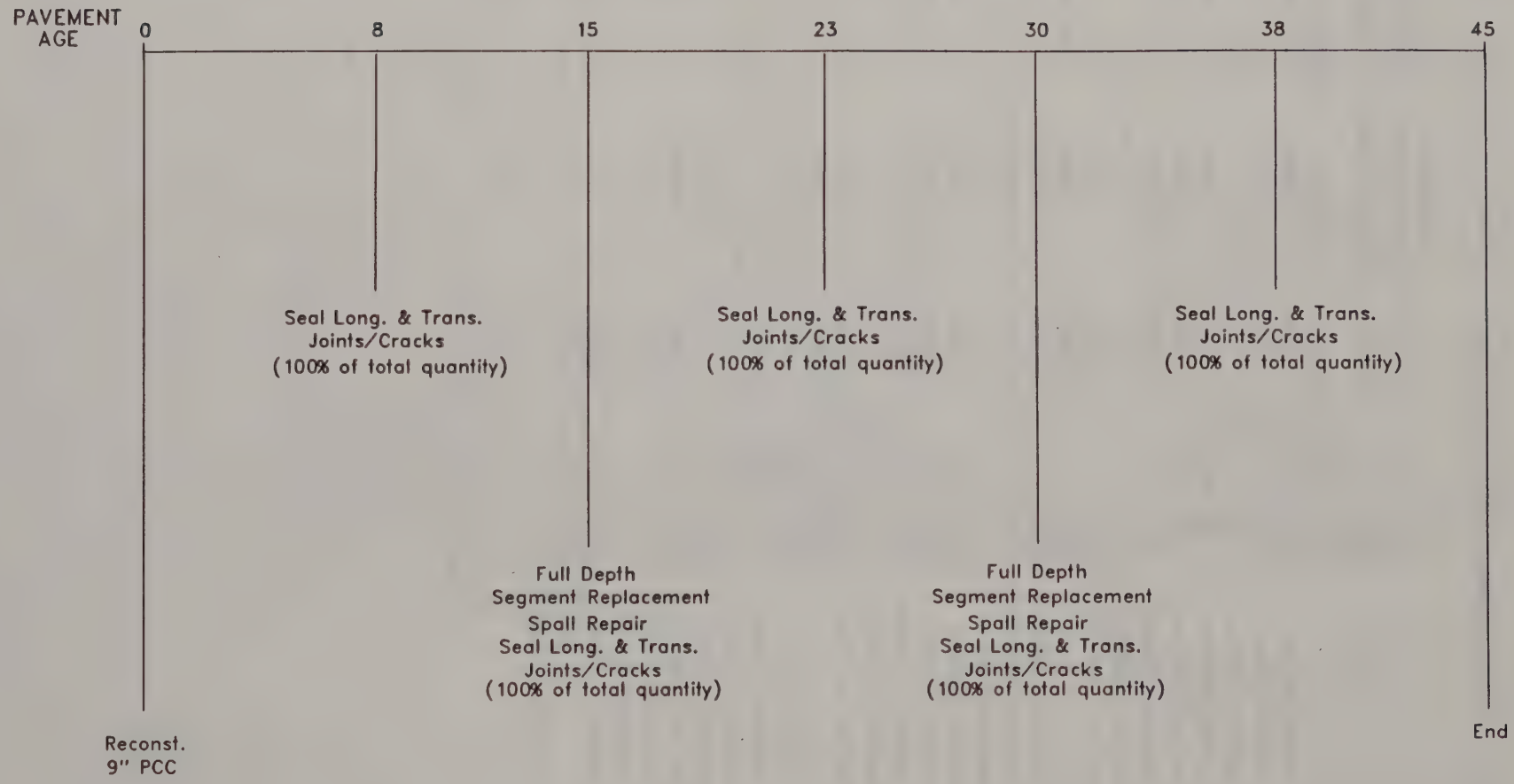
AREA III

RECONSTRUCT WITH 10-1/2" AC

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
Reconstruct 10-1/2" AC	0	$1,894,940	1.0000	$1,894,940
Fill Longitudinal Cracks/Joints	3	524	.8890	466
Rout & Seal Trans. Thermal Cracks	5	12,700	.8219	10,438
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	7	524	.7599	398
Fill Longitudinal Cracks/Joints	9	524	.7026	368
Rout & Seal Trans. Thermal Cracks	11	12,700	.6496	8,250
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	13	524	.6006	315
3" AC Overlay	15	557,618	.5553	309,645
Fill Longitudinal Cracks/Joints	18	1,560	.4936	770
Rout & Seal Trans. Thermal Cracks	20	13,736	.4564	6,2696
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	22	1,560	.4220	658
Fill Longitudinal Cracks/Joints	24	1,560	.3901	609
Rout & Seal Trans. Thermal Cracks	26	13,736	.3607	4,955
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	28	1,560	.3335	520
3" AC Overlay	30	557,618	.3083	171,914
Fill Longitudinal Cracks/Joints	33	1,560	.2741	428
Rout & Seal Trans. Thermal Cracks	35	13,736	.2534	3,481
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	37	1,560	.2343	366
Fill Longitudinal Cracks/Joints	39	1,560	.2166	338
Rout & Seal Trans. Thermal Cracks	41	13,736	.2003	2,751
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	43	1,560	.1852	289
Sub-Total		3,105,096		2,418,168
Rout & Seal Trans. Thermal Cracks 1 Yr. Salvage Value		-2,435	.1712	-417
Total		$3,102,661		$2,417,751

RECONSTRUCT WITH 9" PCC

AREA III



AREA III

RECONSTRUCT WITH 9" PCC

Description	Year (n)	Present Cost	Present Worth Factor (P/F, 4%, n)	Present Worth
Reconstruct 9" PCC	0	$2,779,170	1.0000	$2,779,170
Seal Long. & Trans. Joints/Cracks	8	209,108	.7307	152,795
Pavement Repair & Jt. Sealing	15	335,840	.5553	186,492
Seal Long. & Trans. Joints/Cracks	23	209,108	.4057	84,835
Pavt. Repair & Jt. Sealing	30	501,224	.3083	154,527
Seal Long. & Trans. Joints/Cracks	38	209,108	.2253	47,112
	Total	$4,243,558		$3,404,931

APPENDIX A

Project Information Form

BR-46 (4/91) NYSDoT MATERIALS BUREAU

PAVEMENT EVALUATION REPORT

PROJECT INFORMATION

General

Region: 12 County: Bush Route No.: 66 PIN 9040.90

Project Identification: Somewhere to Nowhere

Begin RM 66-8101-3980 End RM 66-8101-4050 Total Length: 7 miles

Original Contract Date(s): 1962 (Contract No. FAC 62-10)

Latest Pavement Rehabilitation Date(s): Southernmost two miles overlaid by state maintenance forces in 1985

Roadway Features

Roadway: Divided _____ Non-Divided X

Median: Flush _____ Raised _____ Concrete Median Barrier _____

Curbs: Mountable _____ Non-Mountable _____

AC _____ PCC _____ Stone _____

Pavement:

Lanes: No. 2 Width(s) 12'

Type: Reinforced PCC X(5mi) Non-Reinforced PCC _____

AC _____ AC over PCC X(2mi)

Thickness (normal): Total _____ (AC 1" PCC 9")

Reinforced and Non-Reinforced PCC Pavements only:

Slab Length 60'

Load Transfer Type: Dowels _____ 2 Component X

Transverse Joints: Contraction X Expansion _____

Subbase:

Type: Gravel Thickness (nominal): 12"

Shoulders:

Type: AC _____ PCC _____ Gravel X Thickness 3"

AC or Surface Treatment/Stabilized Gravel X Thickness 1"

Width: Both 6' Driving Lane _____ Passing Lane _____

Drainage:

Type: Open System X(5mi) Closed System X(2mi)

Related Pavement Data

Traffic AADT (Range) 12,000-14,000 Date 1988 % Trucks 5

Sufficiency Rating Surface Score 5-7 Date 1989

Prepared By Dusty Rhodes Date 9/90

APPENDIX B

Distress Data Forms

Areas I - III

BR-48(6/90) **NYSDoT MATERIALS BUREAU** AREA I

DISTRESS DATA FORM

Region 13 County Bush Route No. 66 Pin 9040.90 PAVEMENT FLEXIBLE ☐
Number of Lanes 2 Survey Pertinent to 2 Lane(s) All Direction North FLEXIBLE/RIGID ☒
Date Insp. 9/25/90 Inspectors B. Careful, B. Aware Sheet 1 of 4

DISTRESS	SEVERITY		SECTION (1)	(2)	(3)	(4)	(5)	EXTENT TOTAL SUM	EXTENT TOTAL %	REMARKS
		Beginning	3980	3985	3990	3995				
		Ending	3985	3990	3995	4000				
CORRUGATIONS (%)	N	None	10	10	10	10		40	100	
	P	Present						0	0	
SETTLEMENTS & HEAVES (#)	N	None	✓	✓	✓	✓				
	P	Present						0		
ASPHALT CONC. OVERLAY OR SPRAY PATCH (#)	N	None	✓	✓	✓	✓				
	G	Good						0		
	F	Fair						0		
	P	Poor						0		
WHEELPATH CRACKING (%)	N	None	10	10	10	10		40	100	
	L	Single Crack						0	0	
	M	Multiple Cracks						0	0	
	H	Mult. Cracks w/Potholes						0	0	
FULL WIDTH TRANSVERSE CRACKING (#)	N	None								Cracking appears
	L	Single Crack						0		over underlying
	M	Multiple Cracks	𝍸 II	𝍸	𝍸 I	𝍸 III		26		PCC joints
	H	Mult. Cracks w/Potholes	II	IIII	III	I		10		
LONGITUDINAL CRACKING (%)	N	None						0	0	Cracking appears
	L	Single Crack						0	0	over underlying
	M	Multiple Cracks	8	8	7	7		30	75	PCC joints
	H	Mult. Cracks w/Potholes	2	2	3	3		10	25	
EDGE CRACKING (%)	N	None	10	10	10	10		40	100	
	L	Single Crack						0	0	
	M	Multiple Cracks						0	0	
	H	Mult. Cracks w/Potholes						0	0	
CRACKING OTHER (%)	N	None	10	10	10	10		40	100	
	L	Single Crack						0	0	
	M	Multiple Cracks						0	0	
	H	Mult. Cracks w/Potholes						0	0	
SLIPPAGE CRACKS ☑	N	None	✓	✓	✓	✓		4	100	
	P	Present						0	0	
RAVELLING (%)	N	None	10	10	10	10		40	100	
	P	Present						0	0	
WHEELPATH RUTTING (MEASURE) ☑	N	None						0	0	
	L	< 3/8"	✓	✓	✓	✓		4	100	
	M	3/8"–3/4"						0	0	
	H	>3/4"						0	0	
WIDENING DROPOFF (MEASURE) ☑	N	None	✓	✓	✓	✓		4	100	
	L	<3/8"						0	0	
	M	3/8"–3/4"						0	0	
	H	>3/4"						0	0	

SHOULDER SURVEY PERTINENT TO: BOTH ☑ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION ☑	N	None						0	0	
	L	Single Crack						0	0	
	M	Multiple Cracks	✓			✓		2	50	
	H	Mult. Cracks w/Potholes		✓	✓			2	50	
LANE/SHOULDER SEPARATION (MEASURE) ☑	N	None						0	0	
	L	<1/4"/Sealed						0	0	
	M	1/4"–1"	✓	✓	✓	✓		4	100	
	H	>1"						0	0	
LANE/SHOULDER DROPOFF (MEASURE) ☑	N	None						0	0	
	L	< 1"	✓			✓		2	50	
	M	1"–2"		✓	✓			2	50	
	H	>2"						0	0	
SHOULDER DEFORMATION ☑	N	None	✓	✓	✓	✓		4	100	
	P	Present						0	0	

BR-47(6/90) **NYSDoT MATERIALS BUREAU** AREA II

DISTRESS DATA FORM

PAVEMENT RIGID [X]

Region 12 County Bush Route No. 66 Pin 9040.90
Number of Lanes 2 Survey Pertinent to 2 Lane(s) All Direction North
Date Insp. 9/25/90 Inspectors B. Careful, B. Alert Sheet 1 of 1

DISTRESS	SEVERITY		SECTION (1)	(2)	(3)	(4)	(5)	EXTENT TOTAL SUM	EXTENT TOTAL %	REMARKS
		Beginning	4000	4005	4010	4015	4020			
		Ending	4005	4010	4015	4020	4025			
SETTLEMENTS & HEAVES (#)	N	None	✓	✓						(3)(5)over culverts
	P	Present			II	I	II	5		(4)struct. approach
BLOWUPS (#)	Partial Width				I			1		
	Full Width		II			I	I	4		
ASPHALT CONC. OVERLAY PATCHING (#)	N	None	✓	✓						(3)(5)all four approx. 120 ft. long over cross-culverts – 2 lanes
	G	Good						0		
	F	Fair			II		II	4		
	P	Poor						0		
JOINT SEALER FAILURE [✓]	N	None						0	0	original preformed neoprene sealer
	F	Failed	✓	✓	✓	✓	✓	5	100	
TRANSVERSE JOINT FAULTING (MEASURE) [✓]	N	None						0	0	
	L	<3/8"	✓					1	20	
	M	3/8"–3/4"		✓	✓	✓	✓	4	80	
	H	>3/4"						0	0	
TRANSVERSE JOINT SEPARATION (#)			𝍸 I			II		8	18	near blowups
TRANSVERSE JOINT DISTRESS (# JOINTS)	N	No Spalls	II		I		II	5	11	(1)–(5) "D" Crack related
	L	Minor 3" max. Width		III	I	II	II	8	18	
	M	Occs. >3" Width	IIII	III	𝍸	𝍸	I	18	40	
	H	Many >3" Width	III	III	II	II	IIII	14	31	
LONGITDINAL JOINT SEPARATION (#)						𝍸 I		6	15	near blowups
LONGITUDINAL JOINT DISTRESS (# SLABS)	N	No Spalls			II		II	4	10	(1)–(5)"D" Crack related
	L	Minor 2" max. Width	III	II	II	II	II	11	28	
	M	Occs. >2" Width	IIII	𝍸	IIII	𝍸	I	19	47	
	H	Many >2" Width	I	I		I	III	6	15	
SLAB CRACKING (# SLABS)	N	None	I	III	IIII	I	II	11	28	
	L	Light	II	I		II		5	12	
	M	Moderate	II	II	II	𝍸	III	14	35	
	H	Heavy	III	II	II		III	10	25	
WHEELPATH RUTTING (MEASURE) [✓]	N	None	✓			✓		2	40	
	L	< 3/8"		✓	✓		✓	3	60	
	M	3/8"–3/4"						0	0	
	H	>3/4"						0	0	
SCALING/ NON-JOINT SPALLING (# SLABS)	N	None	𝍸 II	𝍸	𝍸 III	𝍸 I	𝍸 III	34	85	
	L	Light	I	III		I		5	13	
	M	Medium				I		1	2	
	H	Heavy						0	0	

SHOULDER SURVEY PERTINENT TO: BOTH [✓] RIGHT [ ] LEFT [ ]

SHOULDER DETERIORATION [✓]	N	None						0	0	
	L	Single Crack						0	0	
	M	Multiple Cracks	✓	✓	✓		✓	4	80	
	H	Mult. Cracks w/Potholes				✓		1	20	
LANE/SHOULDER SEPARATION (MEASURE) [✓]	N	None						0	0	
	L	<1/4"/Sealed						0	0	
	M	1/4"–1"	✓	✓	✓	✓		4	80	
	H	>					✓	1	20	
LANE/SHOULDER DROPOFF (MEASURE) [✓]	N	N:						0	0	
	L	< 1"	✓	✓	✓	✓	✓	5	100	
	M	1"–2"						0	0	
	H	>2"						0	0	
SHOULDER DEFORMATION [✓]	N	None	✓	✓		✓		3	60	(3)(5) at culvert settlements
	P	Present			✓		✓	2	40	

DISTRESS DATA FORM

Region 12 County Bush Route No. 66 Pin 9040.90 PAVEMENT RIGID [X]

Number of Lanes 2 Survey Pertinent to 2 Lane(s) All Direction North

Date Insp. 9/25/90 Inspectors B. Careful, B. Alert Sheet 1 of 1

DISTRESS	SEVERITY		SECTION (1) Beginning 4030 Ending 4035	(2) 4035 4040	(3) 4040 4045	(4) 4045 4050	(5)	EXTENT TOTAL SUM	EXTENT TOTAL %	REMARKS
SETTLEMENTS & HEAVES (#)	N	None			✓					Settlements at
	P	Present	𝍸 I	III		𝍸 II		16		X-drains, util. cuts
BLOWUPS (#)	Partial Width		II		II			4		
	Full Width			II		II		4		
ASPHALT CONC. OVERLAY PATCHING (#)	N	None								
	G	Good						0		
	F	Fair	II	II	I	IIII		9		
	P	Poor	𝍸	IIII	I	𝍸		15		
JOINT SEALER FAILURE ☑	N	None						0	0	original preformed
	F	Failed	✓	✓	✓	✓		4	100	neoprene sealer
TRANSVERSE JOINT FAULTING (MEASURE) ☑	N	None						0	0	
	L	<3/8"						0	0	
	M	3/8"–3/4"	✓	✓	✓	✓		4	100	
	H	>3/4"						0	0	
TRANSVERSE JOINT SEPARATION (#)			IIII	𝍸 I	IIII	𝍸 I		20	56	near blowups
TRANSVERSE JOINT DISTRESS (# JOINTS)	N	No Spalls				I		1	3	(1)–(4) "D" Crack
	L	Minor 3" max. Width	III		II	I		6	17	related
	M	Occs. >3" Width	IIII	𝍸	III	II		14	39	
	H	Many >3" Width	II	IIII	IIII	𝍸		15	41	
LONGITDINAL JOINT SEPARATION (#)			IIII		IIII			8	20	
LONGITUDINAL JOINT DISTRESS (# SLABS)	N	No Spalls						0	0	(1)–(4) "D" Crack
	L	Minor 2" max. Width	IIII	II	III	II		11	34	related
	M	Occs. >2" Width	IIII	𝍸 I	𝍸	III		18	56	
	H	Many >2" Width				III		3	10	
SLAB CRACKING (# SLABS)	N	None	I					1	4	Cracks contain
	L	Light	II	II	I	II		7	22	remnants of
	M	Moderate	IIII	III	IIII	I		12	37	asphalt filler
	H	Heavy	I	III	III	𝍸		12	37	incompressibles
WHEELPATH RUTTING (MEASURE) ☑	N	None						0	0	
	L	< 3/8"	✓	✓	✓	✓		4	100	
	M	3/8"–3/4"						0	0	
	H	>3/4"						0	0	
SCALING/ NON–JOINT SPALLING (# SLABS)	N	None	III	IIII	IIII	IIII		15	47	Spalling caused
	L	Light	𝍸	IIII	III	II		14	44	from high mesh
	M	Medium			I	II		3	9	popouts
	H	Heavy						0	0	

SHOULDER SURVEY PERTINENT TO: BOTH [✓] RIGHT [ ] LEFT [ ]

SHOULDER DETERIORATION ☑	N	None						0	0	
	L	Single Crack						0	0	
	M	Multiple Cracks	✓	✓		✓		3	75	
	H	Mult. Cracks w/Potholes			✓			1	25	
LANE/SHOULDER SEPARATION (MEASURE) ☑	N	None						0	0	
	L	<1/4"/Sealed						0	0	
	M	1/4"–1"	✓	✓	✓	✓		4	100	
	H	>1"						0	0	
LANE/SHOULDER DROPOFF (MEASURE) ☑	N	None						0	0	
	L	< 1"	✓	✓	✓	✓		4	100	
	M	1"–2"						0	0	
	H	>2"						0	0	
SHOULDER DEFORMATION ☑	N	None	✓	✓	✓	✓		4	100	
	P	Present						0	0	

APPENDIX C

Alternative Cost Estimates: Area I

AREA I

TWO-COURSE OVERLAY, 3" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
203.02	Shoulder Excavation	C.Y.	$ 6.00	1,760	$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	293	4,102
403.13	Dense Binder (1-1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal (deep saw cuts may not be required)	L.F.	5.00	2,640	13,200
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07	Clean & Fill Jts./Crks. (this item may not be required)	L.S.(L.F.)	0.50(L.F.)	7,392	3,696
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	271,116
	Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%				92,613
				Total Cost/Mile	363,729
				Total Cost Area I	$727,458

AREA I

FUTURE TREATMENT COSTS
AFTER 2, 4, 6, 14, 16 & 18 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
				Total Item Cost	595
	Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%				185
				Total Cost/Mile	780
				Total Cost Area I	$1,560

AREA I

FUTURE TREATMENT COSTS
AFTER 8, 10, 20, 22, 24 & 26 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	185	$925
	Fill Sawed & Sealed Transverse Joints				
				Total Item Cost	925
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					287
				Total Cost/Mile	1,212
				Total Cost Area I	$2,424

AREA I

FUTURE TREATMENT COSTS AFTER 12 YEARS
TWO-COURSE OVERLAY, 3" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
15304.0117	Shoulder Backup	C.Y.	14.00	293	$ 4,102
403.13	Dense Binder (1-1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
18403.7502	Fill Longitudinal Cracks & Joints.	Gal.	5.00	396	1,980
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal Trans. Jts. (deep saw cuts may not be required)	L.F.	5.00	2,640	13,200
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	197,240
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					67,377
				Total Cost/Mile	264,617
				Total Cost Area I	$529,234

AREA I

FUTURE TREATMENT COSTS AFTER 27 YEARS
SINGLE-COURSE OVERLAY, 1-1/2" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	$58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
490.10	Cold Milling (1-1/2") (pav't & shldrs.)	S.Y.	2.00	21,120	42,240
18502.2599	Saw & Seal Trans. Jts.	L.F.	5.00	2,640	13,200
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	121,008
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					41,336
				Total Cost/Mile	162,344
				Total Cost Area I	$324,688

AREA I

FUTURE TREATMENT COSTS
AFTER 29 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	158	$790
				Total Item Cost	790
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					245
				Total Cost/Mile	1,035
				Total Cost Area I	$2,070

AREA I

MULTIPLE-COURSE OVERLAY, 4" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
203.02	Shoulder Excavation	C.Y.	$ 6.00	1,760	$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	391	5,474
403.13	Dense Binder (1-1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
403.21	Truing & Leveling (1") (pav't & shldrs.)	Ton	34.00	1,117	37,978
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal	L.F.	5.00	2,640	13,200
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07 (this item may not be required)	Clean & Fill Jts./Crks.	L.S.(L.F.)	0.50(L.F.)	7,392	3,696
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	310,466
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					106,055
				Total Cost/Mile	416,521
				Total Cost Area I	$833,042

AREA I

FUTURE TREATMENT COSTS
AFTER 2, 4 & 6 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	80	$400
				Total Item Cost	400
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					124
				Total Cost/Mile	524
				Total Cost Area I	$1,048

AREA I

FUTURE TREATMENT COSTS
AFTER 8, 10, 12 & 14 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	146	$730
	Fill Sawed & Sealed Transverse Joints				
				Total Item Cost	730
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					227
				Total Cost/Mile	957
				Total Cost Area I	$1,914

AREA I

FUTURE TREATMENT COSTS AFTER 15 YEARS
MULTIPLE-COURSE OVERLAY, 3" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
15304.0117	Shoulder Backup	C.Y.	14.00	293	$ 4,102
403.13	Dense Binder (1-1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
18403.7502	Fill Longitudinal Cracks & Joints.	Gal.	5.00	396	1,980
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal Trans. Jts. (deep saw cuts may not be required)	L.F.	5.00	2,640	13,200
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	197,240
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					67,377
				Total Cost/Mile	264,617
				Total Cost Area I	$529,234

AREA I

FUTURE TREATMENT COSTS
AFTER 17, 19 & 21 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
				Total Item Cost	595
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					185
				Total Cost/Mile	780
				Total Cost Area I	$1,560

AREA I

FUTURE TREATMENT COSTS
AFTER 23, 25, 27 & 29 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	185	$925
	Fill Sawed & Sealed Transverse Joints				
				Total Item Cost	925
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					287
				Total Cost/Mile	1,212
				Total Cost Area I	$2,424

APPENDIX D

Alternative Cost Estimates: Area II

AREA II

5" AC OVERLAY PRECEDED BY CRACK & SEAT

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
202.20	Remove AC Overlay (Settlement Areas)	S.Y.	$ 4.00	1,280	$ 5,120
203.02	Shoulder Excavation (Includes Blowup Removal)	C.Y.	6.00	1,770	10,620
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
18203.9904	Crack & Seat PCC	Ln.Mi.	6000.00	2	12,000
15304.0117	Shoulder Backup	C.Y.	14.00	469	6,566
403.13	Dense Binder (3-1/2") (Includes Blowup Repair)	Ton	34.00	3,906	132,804
403.15	Shim Faults	Ton	100.00	6	600
403.1701	Top Course (1-1/2")	Ton	35.00	1,675	58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.4466	Spall Repair	S.F.	7.00	2,800	19,600
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07	Clean & Fill Jts./Crks.	L.S.(L.F.)	0.50(L.F.)	6,800	3,400
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	317,878
	Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%				108,587
				Total Cost/Mile	426,465
				Total Cost Area II	$1,279,395

AREA II

FUTURE TREATMENT COSTS
AFTER 3, 7, 9 & 13 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	80	$400
				Total Item Cost	400
	Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%				124
				Total Cost/Mile	524
				Total Cost Area II	$1,572

AREA II

FUTURE TREATMENT COSTS
AFTER 5 & 11 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	80	$400
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	1,901	4,182
				Total Item Cost	4,582
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					1,422
				Total Cost/Mile	6,004
				Total Cost Area II	$18,012

AREA II

FUTURE TREATMENT COSTS AFTER 15 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
15304.0117	Shoulder Backup	C.Y.	14.00	293	$ 4,102
403.13	Dense Binder (1-1/2")	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2")	Ton	35.00	1,675	58,625
18403.7502	Fill Cracks	Gal.	5.00	396	1,980
-	Mill & Patch	S.Y.	45.00	422	18,990
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	147,590
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					50,416
				Total Cost/Mile	198,006
				Total Cost Area II	$594,018

AREA II

FUTURE TREATMENT COSTS
AFTER 18, 22, 24, 28, 33, 37, 39 & 43 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
			Total Item Cost		595
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					185
			Total Cost/Mile		780
			Total Cost Area II		$2,340

AREA II

FUTURE TREATMENT COSTS
AFTER 20, 26, 35 & 41 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	1,901	4,182
			Total Item Cost		4,777
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					1,483
			Total Cost/Mile		6,260
			Total Cost Area II		$18,780

AREA II

FUTURE TREATMENT COSTS AFTER 30 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
403.13	Dense Binder (1-1/2")	Ton	$34.00	1,675	$56,950
403.1701	Top Course (1-1/2")	Ton	35.00	1,675	58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
490.10	Cold Milling (3") (pav't. & shldrs.)	S.Y.	3.00	21,120	63,360
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	185,878
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					63,496
				Total Cost/Mile	249,374
				Total Cost Area II	$748,122

AREA II

RECONSTRUCT WITH 10-1/2" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
01202.97	Pavement Removal	S.Y.	$ 10.00	14,080	$140,800
203.02	Shoulder Excavation	C.Y.	6.00	1,760	10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,467	24,939
403.11	Dense Base (7")	Ton	34.00	5,182	176,188
403.13	Dense Binder (2" pav't.) & (1-1/2" Shldr.)	Ton	34.00	2.077	70,618
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	516,974
Overhead Factors: Prelim. Engr. 8%, Mobil. 4%, M&PT 10%, Survey 4%, Const. Insp. 12%					221,116
				Total Cost/Mile	738,090
				Total Cost Area II	$2,214,270

AREA II

FUTURE TREATMENT COSTS
AFTER 3, 7, 9 & 13 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	40	$200
				Total Item Cost	200
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					62
				Total Cost/Mile	262
				Total Cost Area II	$786

AREA II

FUTURE TREATMENT COSTS
AFTER 5 & 11 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	40	$200
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	1,901	4,182
				Total Item Cost	4,382
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					1,360
				Total Cost/Mile	5,742
				Total Cost Area II	$17,226

AREA II

FUTURE TREATMENT COSTS AFTER 15 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
15304.0117	Shoulder Backup	C.Y.	14.00	293	$ 4,102
403.13	Dense Binder (1-1/2")	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2")	Ton	35.00	1,675	58,625
18403.7502	Fill Cracks	Gal.	5.00	396	1,980
-	Mill & Patch	S.Y.	45.00	422	18,990
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	147,590
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					50,417
				Total Cost/Mile	198,007
				Total Cost Area II	$594,021

AREA II

FUTURE TREATMENT COSTS
AFTER 18, 22, 24, 28, 33, 37, 39 & 43 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
				Total Item Cost	595
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					185
				Total Cost/Mile	780
				Total Cost Area II	$2,340

AREA II

FUTURE TREATMENT COSTS
AFTER 20, 26, 35 & 41 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	1,901	4,182
				Total Item Cost	4,777
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					1,483
				Total Cost/Mile	6,260
				Total Cost Area II	$18,780

AREA II

FUTURE TREATMENT COSTS AFTER 30 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
403.13	Dense Binder (1 1/2")	Ton	$34.00	1,675	$56,950
403.1701	Top Course (1 1/2")	Ton	35.00	1,675	58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
490.10	Cold Milling (3") (pav't. & shldrs.)	S.Y.	3.00	21,120	63,360
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	185,878
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					63,496
				Total Cost/Mile	249,374
				Total Cost Area II	$748,122

AREA II

RECONSTRUCT WITH 9" PCC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
01202.97	Pavement Removal	S.Y.	$ 10.00	14,080	$140,800
203.02	Shoulder Excavation	C.Y.	6.00	1,760	10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,173	19,941
403.13	Dense Binder (for 3" shldr.)	Ton	34.00	1,117	37,978
502.06	Cement Conc. Pav't.	C.Y.	80.00	3,250	281,600
502.20	Trans. Jt. Supports	L.F.	8.00	6,336	50,688
502.30	Long. Jt. Ties	EA.	4.00	1,320	5,280
18502.44201	Const. & Seal Jts.	L.F.	7.00	11,616	81,312
17605.2402	Edgedrains	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	663,403
Overhead Factors: Prelim. Engr. 8%, Mobil. 4%, M&PT 10%, Survey 4%, Const. Insp. 12%					283,745
				Total Cost/Mile	947,148
				Total Cost Area II	$2,841,444

AREA II

FUTURE TREATMENT COSTS
AFTER 2, 4, 6, 10, 12, 14, 17, 19, 21, 25, 27 & 29 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7503	Fill Shldr. Jts.	Gal.	$12.00	132	$1,584
				Total Item Cost	1,584
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					492
				Total Cost/Mile	2,076
				Total Cost Area II	$6,228

AREA II

FUTURE TREATMENT COSTS
AFTER 8 & 23 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18502.70200	Reseal Trans. Jts.	L.F.	$3.00	6,336	$19,008
18502.7401	Reseal Long. Jts.	L.F.	3.00	5,280	15,840
18403.7503	Fill Shldr. Jts.	Gal.	12.00	132	1,584
				Total Item Cost	36,432
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					11,308
				Total Cost/Mile	47,740
				Total Cost Area II	$143,220

AREA II

FUTURE TREATMENT COSTS AFTER 15 YEARS

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
203.02	Shoulder Excavation	C.Y.	$ 6.00	587	$ 3,522
01203.02998	Pav't Lift Out	S.Y.	20.00	214	4,280
403.13	Dense Binder (for 3" shldrs.)	Ton	34.00	1,117	37,978
18502.0701	Surface Prep.	S.F.	25.00	200	5,000
18502.0702	RS Pav't. Repair	LB.	1.50	4,168	6,252
502.11	Metal Reinf.	S.Y.	5.50	214	1,177
502.20	Trans. Jt. Supp.	L.F.	8.00	192	1,536
10502.6088	Conc. Repair	C.Y.	150.00	54	8,100
18502.70200	Reseal Trans. Jts.	L.F.	3.00	6,144	18,432
18502.7101	Saw & Seal Jts.	L.F.	5.00	272	1,360
18502.7401	Reseal Long. Jts.	L.F.	3.00	5,200	15,600
18502.7601	Seal Pav't. Cracks	L.F.	3.00	144	432
586.01	Drill & Grout Rebars	L.F.	18.00	144	2,592
				Total Item Cost	106,261
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					36,299
				Total Cost/Mile	142,560
				Total Cost Area II	$427,680

AREA II

FUTURE TREATMENT COSTS AFTER 30 YEARS
3" SAWED & SEALED AC OVERLAY

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
203.02	Shoulder Excavation	C.Y.	$ 6.00	1,760	$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	293	4,102
403.13	Dense Binder (1 1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1 1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal	L.F.	5.00	7,920	39,600
18502.4466	Spall Repair	S.F.	7.00	600	4,200
18633.06	Clean Pav't.	S.Y.	0.06	14,080	845
18633.07	Clean & Fill Jts./Crks.	L.S.(L.F.)	0.50(L.F.)	11,616	5,808
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
				Total Item Cost	216,286
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					73,883
				Total Cost/Mile	290,169
				Total Cost Area II	$870,507

AREA II

FUTURE TREATMENT COSTS
AFTER 32, 34 & 36 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
				Total Item Cost	595
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					185
				Total Cost/Mile	780
				Total Cost Area II	$2,340

AREA II

FUTURE TREATMENT COSTS
AFTER 38, 40, 42 & 44 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints Fill Sawed & Sealed Transverse Joints	Gal.	$5.00	317	$1,585
				Total Item Cost	1,585
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					492
				Total Cost/Mile	2,077
				Total Cost Area II	$6,231

APPENDIX E

Alternative Cost Estimates: Area III

AREA III

6" AC OVERLAY PRECEDED BY RUBBLIZING

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
202.20	Remove AC Overlay (settlement areas)	S.Y.	$ 4.00	214	$ 856
203.02	Shldr. & Gutter Excav. (includes blowups)	C.Y.	6.00	2,654	15,924
206.02	Trench & Culvert Excav.	C.Y.	13.00	587	7,631
304.03	Subbase Course (crushed stone)	C.Y.	20.00	2,654	53,080
403.13	Dense Binder (4-1/2")	Ton	34.00	5,584	189,856
403.1701	Top Course (1-1/2")	Ton	35.00	1,861	65,135
18502.7590	Rubblize PCC	S.Y.	5.00	14,080	70,400
605.0901	Underdrain Filter	C.Y.	30.00	587	17,610
605.1701	Underdrain	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	17,512	5,254
				Total Item Cost	457,426
Overhead Factors: Prelim. Engr. 8%, Mobil. 4%, M&PT 7.5%, Survey 4%, Const. Insp. 12%					180,804
				Total Cost/Mile	638,230
				Total Cost Area III	$1,276,460

Note: Curb construction, sidewalk replacement, drainage adjustments and connections, and other incidental construction items are not included in this estimate. These additions will of course increase the overhead and total cost. However, cost increases as a result of these additions will be comparable for each of the selected alternatives. Therefore, their inclusion does not influence alternative comparison.

AREA III

FUTURE TREATMENT COSTS
AFTER 3, 7, 9 & 13 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	40	$200
				Total Item Cost	200
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					62
				Total Cost/Mile	262
				Total Cost Area III	$524

AREA III

FUTURE TREATMENT COSTS
AFTER 5 & 11 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	40	$200
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	2,112	4,646
				Total Item Cost	4,846
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					1,504
				Total Cost/Mile	6,350
				Total Cost Area III	$12,700

AREA III

FUTURE TREATMENT COSTS AFTER 15 & 30 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
403.13	Dense Binder (1 1/2")	Ton	$34.00	1,861	$63,274
403.1701	Top Course (1 1/2")	Ton	35.00	1,861	65,135
407.0101	Tack Coat	Gal.	2.00	1,173	2,346
490.10	Cold Milling (3")	S.Y.	3.00	23,467	70,401
18633.06	Clean Pav't.	S.Y.	0.06	23,467	1,408
18685.06	Pav't Marking	L.F.	0.30	17,512	5,254
				Total Item Cost	207,818
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					70,991
				Total Cost/Mile	278,809
				Total Cost Area III	$557,618

AREA III

FUTURE TREATMENT COSTS
AFTER 18, 22, 24, 28, 33, 37, 39 & 43 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
				Total Item Cost	595
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					185
				Total Cost/Mile	780
				Total Cost Area III	$1,560

AREA III

FUTURE TREATMENT COSTS
AFTER 20, 26, 35 & 41 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	2,112	4,646
				Total Item Cost	5,241
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					1,627
				Total Cost/Mile	6,868
				Total Cost Area III	$13,736

AREA III

RECONSTRUCT WITH 10-1/2" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
01202.97	Pavement Removal	S.Y.	$ 10.00	14,080	$140,800
203.02	Shldr. Gutter Excav.	C.Y.	6.00	2,640	15,840
206.02	Trench & Culvert Excav.	C.Y.	13.00	587	7,631
403.11	Dense Base (7")	Ton	34.00	8,685	295,290
403.13	Dense Binder (2")	Ton	34.00	2,482	84,388
403.1701	Top Course (1 1/2")	Ton	35.00	1,861	65,135
605.0901	Underdrain Filter	C.Y.	30.00	587	17,610
605.1701	Underdrain	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	17,512	5,254
				Total Item Cost	663,628
Overhead Factors: Prelim. Engr. 8%, Mobil. 4%, M&PT 10%, Survey 4%, Const. Insp. 12%					283,842
				Total Cost/Mile	947,470
				Total Cost Area III	$1,894,940

NOTE: Curb construction, sidewalk replacement, drainage adjustments and connections, and other incidental construction items are not included in this estimate. These additions will of course increase the overhead and total cost. However, cost increases as a result of these additions will be comparable for each of the selected alternatives. Therefore, their inclusion does not influence alternative comparison.

AREA III

FUTURE TREATMENT COSTS
AFTER 3, 7, 9 & 13 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	40	$200
				Total Item Cost	200
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					62
				Total Cost/Mile	262
				Total Cost Area III	$524

AREA III

FUTURE TREATMENT COSTS
AFTER 5 & 11 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	40	$200
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	2,112	4,646
				Total Item Cost	4,846
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					1,504
				Total Cost/Mile	6,350
				Total Cost Area III	$12,700

AREA III

FUTURE TREATMENT COSTS AFTER 15 & 30 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
403.13	Dense Binder (1 1/2")	Ton	$34.00	1,861	$63,274
403.1701	Top Course (1 1/2")	Ton	35.00	1,861	65,135
407.0101	Tack Coat	Gal.	2.00	1,173	2,346
490.10	Cold Milling (3")	S.Y.	3.00	23,467	70,401
18633.06	Clean Pav't.	S.Y.	0.06	23,467	1,408
18685.06	Pav't Marking	L.F.	0.30	17,512	5,254
				Total Item Cost	207,818
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					70,991
				Total Cost/Mile	278,809
				Total Cost Area III	$557,618

AREA III

FUTURE TREATMENT COSTS
AFTER 18, 22, 24, 28, 33, 37, 39 & 43 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
				Total Item Cost	595
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					185
				Total Cost/Mile	780
				Total Cost Area III	$1,560

AREA III

FUTURE TREATMENT COSTS
AFTER 20, 26, 35 & 41 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	$5.00	119	$595
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	2,112	4,646
				Total Item Cost	5,241
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					1,627
				Total Cost/Mile	6,868
				Total Cost Area III	$13,736

AREA III

RECONSTRUCT WITH 9" PCC

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
01202.97	Pavement Removal	S.Y.	$ 10.00	14,080	$140,800
203.02	Shldr. Gutter Excav.	C.Y.	6.00	2,640	15,840
206.02	Trench & Culvert Excav.	C.Y.	13.00	587	7,631
502.06	Cement Conc. Pav't.	C.Y.	80.00	5,867	469,360
502.20	Trans. Jt. Supports	L.F.	8.00	10,560	84,480
502.30	Long. Jt. Ties	EA.	4.00	3,960	15,840
18502.4420	Const. & Seal Joints	L.F.	7.00	26,400	184,800
605.0901	Underdrain Filter	C.Y.	30.00	587	17,610
605.1701	Underdrain	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	17,512	5,254
				Total Item Cost	973,295
Overhead Factors: Prelim. Engr. 8%, Mobil. 4%, M&PT 10%, Survey 4%, Const. Insp. 12%					416,290
				Total Cost/Mile	1,389,585
				Total Cost Area III	$2,779,170

Note: Curb construction, sidewalk replacement, drainage adjustments and connections, and other incidental construction items are not included in this estimate. These additions will of course increase the overhead and total cost. However, cost increases as a result of these additions will be comparable for each of the selected alternatives. Therefore, their inclusion does not influence alternative comparison.

AREA III

FUTURE TREATMENT COSTS
AFTER 8, 23 & 38 YRS.

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
18502.7401	Reseal Long. Jts.	L.F.	$3.00	15,780	$47,340
18502.70200	Reseal Trans. Jts.	L.F.	3.00	10,416	31,248
18502.7601	Seal Pav't. Cracks	L.F.	3.00	400	1,200
				Total Item Cost	79,788
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					24,766
				Total Cost/Mile	104,554
				Total Cost Area III	$209,108

AREA III

FUTURE TREATMENT COSTS AFTER 15 YEARS

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
01203.02998	Pav't Lift Out	S.Y.	20.00	320	$6,400
18502.0701	Surface Prep.	S.F.	25.00	300	7,500
18502.0702	RS Pav't. Repair	LB.	1.50	6,250	9,376
502.11	Metal Reinf.	S.Y.	5.50	320	1,760
502.20	Trans. Jt. Supp.	L.F.	8.00	288	2,304
10502.6088	Conc. Repair	C.Y.	150.00	80	12,000
18502.70200	Reseal Trans. Jts.	L.F.	3.00	10,272	30,816
18502.7101	Saw & Seal Jts.	L.F.	5.00	768	3,840
18502.7401	Reseal Long. Jts.	L.F.	3.00	15,360	46,080
18502.7601	Seal Pav't. Cracks	L.F.	3.00	400	1,200
586.01	Drill & Grout Rebars	L.F.	18.00	216	3,888
				Total Item Cost	125,164
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					42,756
				Total Cost/Mile	167,920
				Total Cost Area III	$335,840

AREA III

FUTURE TREATMENT COSTS AFTER 30 YEARS

Item No.	Description	Unit	Cost/Unit	Qty./Mile	Cost
01203.02998	Pav't Lift Out	S.Y.	20.00	640	$12,800
18502.0701	Surface Prep.	S.F.	25.00	900	22,500
18502.0702	RS Pav't. Repair	LB.	1.50	18,750	28,125
502.11	Metal Reinf.	S.Y.	5.50	640	3,520
502.20	Trans. Jt. Supp.	L.F.	8.00	576	4,608
10502.6088	Conc. Repair	C.Y.	150.00	160	24,000
18502.70200	Reseal Trans. Jts.	L.F.	3.00	9,984	29,952
18502.7101	Saw & Seal Jts.	L.F.	5.00	1,536	7,680
18502.7401	Reseal Long. Jts.	L.F.	3.00	14,880	44,640
18502.7601	Seal Pav't. Cracks	L.F.	3.00	400	1,200
586.01	Drill & Grout Rebars	L.F.	18.00	432	7,776
				Total Item Cost	186,801
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					63,811
				Total Cost/Mile	250,612
				Total Cost Area III	$501,224

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